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IN TWO SECTIONS December 29, 1927 SECTION ONE

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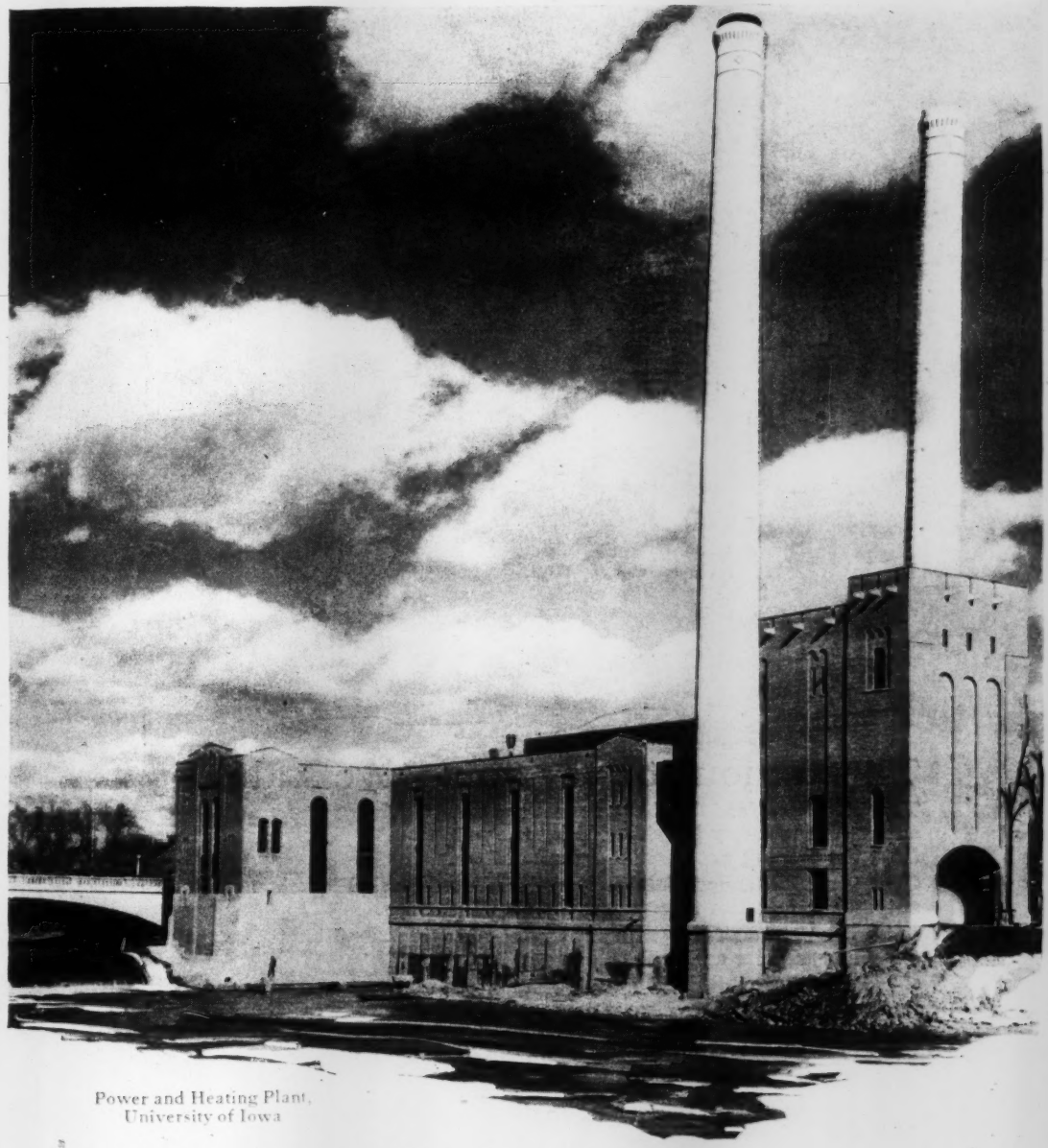

Power and Heating Plant, University of Iowa

Three Studies of Sewage Chlorination

Tunneling at Musconetcong

Today on the Mississippi—

The Sugar Cane Industry and Atchafalaya Crevasses

Arc Welding on a Large Building

Repair of Hurricane Damage to Two Miami Buildings

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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"Please Hurry!"

TRAGEDY in its darkest aspect cast a gloom over the past week. The sinking of the submarine S-4 a week before Christmas off Provincetown darkened many a day. Once again, as when the S-51 was sunk two years ago, the nation waited in breathless suspense for a word of hope that the men entombed in the sunken vessel might be saved from certain fate. Once again there came reports only of impotent groping of divers around the deep-lying hulk. A few despairing messages were rapped out in hammer code by the doomed men, and then came silence—hours before a bit of air could be pumped into the prison chamber through a single small pipe. There were no air locks for entrance to the torpedo room or escape of those confined in it, no hooks or rings by which the hulk could be raised, no device by which a sister submarine could bridge across. Built to destroy, the submarine had no life-saving element in its make-up. And, worse yet, the Navy had no rescue provisions in its equipment. Perhaps this must be so, but the lay mind refuses to believe it; just as it insists that private industry shall not dispense with safety measures, so it feels now that the Navy can and ought to retrieve its name from a black record of steadily repeated disaster by proving that it is able to guard the lives of its men. After such a tragic occurrence as the sinking of the S-4, it is meet that the keenest minds from different walks of life be called together officially to join in thought for future submarine safety. But, of course, that is not to be. Obedient to the dictates of tradition, the Navy itself will investigate the fate of the S-4. May the deliberations of the board be urged on by memory of the dead men's call, *"Please hurry!"* and the helpless answer of those outside, *"We are doing everything possible."*

Sewage Chlorination

STUDIES of sewage chlorination have been numerous of late. In this country they have extended from New England to Texas with rumors of similar investigations in California. Abroad, engineers in Singapore, prompted by the account in our columns of the earlier series of investigations at Schenectady, N. Y., started the use of chlorine immediately and sent this journal a report of results within a year of the time that news from Schenectady reached them. Elsewhere in this issue we present three articles on chlorination studies at as many places. Most of the eight studies thus far reported have been on a working scale, usually with the co-operation of state departments of health. The results promise a rapid increase in the use of sewage chlorination for a wide range of objects: Control of offensive odors, foaming, the fly nuisance, nozzle clogging, ponding of filter beds, as well as for bacterial reduction. Except for fly control, as to which there is some doubt, sewage chlorination seems to have been successful for all the purposes named. More light is needed as to its effect upon nitrification in filter beds, experience and opinion as to this being somewhat conflicting. More cost data are also needed, especially as bearing upon chlorination with little or no pre-treatment. In the latter respect, engineers will need to balacne high cost of chlorine and low capital charges for equipment against the operating and capital charges of pre-treatment works. A great advantage of chlorination is its flexibility. It may be discontinued for days, weeks or months, chlorine saved and no costly equipment left standing idle. Finally, while it is not to be expected that sewage chlorination will increase rapidly as has water chlorination, its wide use in the near future seems assured.

Not Reassuring

ACCORDING to the coroner's jury which has just brought in a belated verdict on the great gasholder explosion in Pittsburgh on Nov. 14, the explosion was an accident. It is by no means a reassuring verdict. It says something about leaky valves, though it does not explain why the leakage of these valves had not been detected at an earlier stage of the repair work on the holder. All in all, it throws no useful light on the circumstances or origin of the explosion. Unless our logic is seriously at fault, the verdict which characterizes the occurrence as an "accident" means that it was an unpreventable happening, such a thing as we must expect every now and then despite reasonable care. Is this possible? Does a constant, imminent hazard of grave accident attach to gas production and storage? The past record of the gas industry does not support the charge of such hazard. It would be criminal to permit gasholders in the midst of city populations if they were subject to unforeseen explosions, sure to devastate a wide territory. Since the coroner's verdict leaves the matter in this uncertain condition, the authorities of the city of Pittsburgh and the State of Pennsylvania, and also such technical representatives of the industry as the American Gas Association, owe the world a more adequate exploration of the causes of the accident. If the causes are found to be of the preventable class, it will be possible—and obviously necessary—to frame rules of safety. Should it prove that they are quite fortuitous, on the other hand, it will be certain that cities are exposed to a great unguarded danger, one which ought promptly to be removed by isolation in a distant location. The question at issue is altogether too big to be left in a state of doubt. Let the facts be brought to light.

Six Young Lawyers

THE investigation of charges against the president of Queens Borough, New York City, noted in these columns last week, promises to be the most thoroughgoing of any coming out of charges of city misgovernment in

the United States. The governor, on receiving the charges summarized on p. 1021 of our last issue, delegated the trial to a supreme court judge of high standing who promptly "drafted" as chief investigator a New York lawyer who has made a reputation in such matters. The investigator immediately announced the engagement of six young lawyers, accustomed to investigation team work under him, as lieutenants. To gain public interest and confidence in the investigation, the names, scholastic and legal training of these six lawyers were speedily announced—and given front-page space in the daily press. All six graduated from leading universities, half of them with the Phi Beta Kappa key. All but one have either been Rhodes scholars at Oxford or else taken post-graduate law courses in America, and one did both. One has been editor and another editor-in-chief of a law school journal. Three resigned positions as assistant United States district attorneys to enter on the Queens investigation. All this about six young lawyers is set forth in appreciation of how a lawyer, attacking a huge civic problem, loses no time to give due credit to his legal assistants. How many engineers in like positions would do the same for their engineer-lieutenants? Inasmuch as the charges thus far made originated in allegations of collusion, high cost and incompetence in carrying on an immense engineering project and the investigation is likely to take up highway and other public works, it is safe to assume that engineers will be engaged to assist in the work. It will be interesting to see whether like publicity will be given to them by their chief, whether he be lawyer or engineer, and by the daily press.

Tunnel Lining Machines

TUNNEL lining with concrete is developing extraordinarily large mobile plant units. The lining traveler described in this isue as employed at Musconetcong is an example. Here is an outfit of size and weight that places it among the largest mobile units used in construction and whose many functions make it virtually a factory for producing tunnel lining in place. It is not a unique example, either in size or complexity. At the Cascade tunnel half a dozen lining machines, each as large and all much more comprehensive as to functions performed, are now in use. Indeed any modern tunneling operation of which concrete lining is a part exhibits similar plants, less or greater than those mentioned, as the occasion demands. In general the change is universal from the older practice of building the lining in stages with separate forms for each stage and the forms not mobile but merely portable. What does the change promise? It is probable that experience is not yet ready to give the answer. Certainly it seems plain that practice has not got beyond the cut-and-try period of development. Some are using steel forms and some forms of wood; some are mixing the concrete on the lining traveler and some are hauling it mixed to the traveler; some are stressing pneumatic placing and others are keeping it down to the least amount, and all are contemplating improvements, large or small, when the next traveler is built and the service to it is planned. There is in this condition a resemblance to that preceding the standardizing of traveling plant for laying concrete pavement. In the end the large and heavy mobile unit equipped to perform all fabricating processes was broken down into several units operating in succession with a great simplification of operations. As one regards the enormous lining travelers at Musconetcong and at other tunnels, the question arises whether a breaking-down process might not be as advantageous in tunnel lining as it has proved to be in concrete paving.

Road Convention Improvement

ALREADY culminating every year in a larger exhibition than in previous years of road building equipment and materials, the efforts of the managers of the American Road Builders Association are being turned toward developing a meeting for technical papers and discussions which is commensurate in interest and popularity. This determination is timely. Born of the A.R.B.A. convention, the road show has grown far beyond the stature of its progenitor. It is each year the greatest exhibition of its kind and one of the greatest of any kind. Equal distinction is not true of the convention.

The convention has not failed. Every year its program becomes longer and the aggregate attendance perhaps a little larger and possibly the papers read a little wider in range and a little richer in information, but the technical meeting is not great in quality and in attendance as the exhibition is great. Perhaps this should be regarded as inevitable. The science and technique of an industry naturally appeal to fewer than does its commerce, arouse less personal concern and admit of less showmanship. But even this philosophy does not explain the situation which prevails; much less does it excuse quiescence under the situation. It is imperative that it be changed.

How? By better papers and their presentation in a better way? By better leadership of the sessions? By better showmanship? By better convention mechanism in general? All these, it may be answered, but considerably more. The exhibitors have the greater part to play. Directly and indirectly they can increase the convention attendance and stiffen up its programs. The highway engineer and contractor members of the A.R.B.A. are not confessing helplessness by asking the co-operation of the exhibitor nor is the exhibitor intruding beyond his rightful functions in extending co-operation.

Road equipment and materials are engineering products and their efficient and wise use is construction engineering of the highest character. There is not a large exhibitor at the road show whose staff of engineers does not contain men who have not only expert knowledge of the use of machines and materials but sound experence and wise opinion on broad policies and practices of road building and maintenance. These men have as much to give the technical meetings as they have to give the road show visitors to their exhibits. They have the great possibility of inducting into the convention thinking that element of equipment consciousness which is essential in modern construction engineering. They are experts to whom the individuals of the convention audiences go often to learn: what they do well for individuals they can do in some fashion at least for convention assemblages of individuals. They should be encouraged by the convention program makers and delegated by their employers to do it. Incidentally the exhibitor might stress this effort somewhat by bearing down less on the distractions of his entertainment program.

Paying for Flood Control

WITH extremely few exceptions those who live in the Mississippi Valley south of Cairo express themselves in no uncertain terms as to who shall bear the cost of flood control. In that large section of the country which is most vitally affected, therefore, the suggestion of the Chief of Engineers in his recent report that 20 per cent of the cost of flood control be borne locally has been received with violent opposition. The principle of states' rights, so long a tenet held to in this section with religious fervor, has been thrown to the winds. Argument concerning the subject dwells only briefly on economic principles, but soon turns to the human-interest factors involving protection of life and homes, and these factors are then pressed in such a way that few individuals are willing to pursue the opposition argument lest they be accused of heartlessness.

Nevertheless the subject has an economic side, and General Jadwin is to be commended for bringing it out and facing the situation squarely and firmly. As he says so succinctly, "the question must be viewed from the standpoint not only of those in the valley needing flood protection but also of the taxpayers in other parts of the country, including the regions from which the flood waters come, who suffer indirectly from flood disasters and on whom the bulk of the burden of federal expenditures must fall." Recognizing the humanitarian viewpoint, justification of any financial plan must be capable of being put into tangible figures.

Values in the valley are placed at $5,000,000,000. This total includes $2,700,000,000 for farm and small-town values, $800,000,000 for New Orleans, and $1,500,000,000 for movable property. The Jadwin plan of control calls for an expenditure of six per cent of the valuation; or, if spread over the acreage only, it represents an average of $25 per acre. The cost of permanent protection, $300,000,000, is only 50 per cent in excess of the $200,000,000 estimated loss in the 1927 flood alone!

These are the basic figures, and from them the simple question evolves whether it is good business to spend $3 once, to save recurring losses of $2 plus. If the losses are frequent enough, it would seem good business indeed, on the simple money-back basis. The report does not go into probable future flood frequency, and so the dollars-and-cents argument cannot be followed much farther. However, General Jadwin declares that the expenditures are justified even if the 1927 flood should recur but once in 150 years.

Immediately comes the question as to who will get this money back, where will the benefit be felt, and who therefore should bear the original cost.

Obviously such a large part of the saving through the protection to be obtained is local that there can be no question of the reasonableness of local participation. The valley states accept that argument for the moment, but come back with the rejoinder that they have already done their share. The Chief of Engineers deals with this argument by presenting a table showing that 63 per cent of the $238,000,000 total spent on flood control since 1882 has been furnished by the states, under the present Flood Control Act provisions requiring the local interests to pay one-third the cost of the levees. Actually, of the completed levees, including rights of way and property damages, the states have borne their one-third.

The Chief of Engineers recognizes that a larger share should be borne by the federal government, but he still feels that something should be borne by local interests, and accordingly suggests an 80-20 split on the cost of structures, to give them "proprietary interest and watchfulness." This is not where the shoe pinches. The cost of right-of-way, easements and property damages in the past has been such as to make the local expenses double that of the government even though the latter paid two-thirds construction cost; in consequence the recommended 80 per cent participation by the government in structure costs may not be so generous as it appears. Without estimates of these property costs it is difficult to determine what is fair as to apportionment.

Surely the states must bear some portion of the cost, though there does not appear a mathematical basis on which to determine that percentage. Past experience with the Reclamation Service may be appealed to as an example of full federal financing; but the impoverishing outcome of that financial adventure has been so disastrous that the Valley States cannot deliberately seek to repeat the experience.

Another factor of importance not taken into account in the report is some estimate of the prospective values which the protection will create. In any one case this may possibly be worked out. In land reclamation by a drainage district its financial backers can reasonably foretell where the project will stand financially in say five, ten or twenty years. Where will flood protection put the cotton growers of Tallulah, or the planters in the "Sugar Bowl," or the muskrat trappers of the lower valley? Are not the cotton and sugar growers going to have so much more produce grown that after all their in-pocket yield is not increased but actually decreased? Such was the case with many cotton planters when they compared 1926 with 1927. Three million bales of cotton were grown in 1926 in excess of 1927, reducing the price below production costs. If that is going to be the result local interests may not be better off and better able to bear their share in five years than now.

Three million farmers migrated to the cities in the last five years. Millions of acres of pasture land were plowed up and put in crops during the war and 5,000,000 acres of forest were cleared for crops. Not one-half of this acreage was needed; so in the next five years 31,000,000 acres of farm land went out of use. Here are significant facts of farm economics. Should not farm economists be brought in to confer with the engineers to determine how much land really is needed out of the 12,000,000 acres it is proposed to protect in the Mississippi Delta?

When thousands of square miles of farm land throughout the country have been abandoned, is it fair to tax the remainder for $300,000,000 to put 12,000,000 acres actively into competition with it? Some one should balance the delta land with the upland areas as to relative fertility, nearness to market and other economic agricultural factors. Such economic questions have vital bearing on the cost apportionment question, if the ability-to-pay principle is to govern. And this latter is virtually what the states are setting up in their accentuated pleas of poverty. Such pleas lead one fast to the not-worth-saving idea.

In general, then, one must conclude that the 80-20 apportionment in the report is, as the report states, only a suggestion to Congress. It is not based on mathematical deduction—nor can it be, with the available information. Economic surveys are essential and future developments should be predicted, all viewed and tempered in the light of the agricultural needs of the nation as a whole.

Three Studies of Sewage Chlorination

Laboratory Tests on Digestion at Harvard University and Field Studies at Independence, Kan., and Bridgeport, Conn., on Odor Control and on Effect of Chlorination on Screened Sewage

The results of three independent studies upon sewage chlorination are given in the following articles. Laboratory tests at Harvard University indicate that pre-chlorination of sewage favors rapid digestion of settled solids. Field studies at Independence, Kansas, show that effective odor control can be obtained by pre-chlorination at a cost of $3.32 per m.g.d. At Bridgeport, Conn., studies made by the Connecticut State Health Department show the need of 10 to 15 p.p.m. of chlorine and frequent ortho-tolidin tests.—EDITOR.

Effect of Chlorination Upon the Digestion of Sewage Solids

Laboratory Tests Indicate That Pre-chlorination of Sewage Favors Rapid Digestion of the Settled Solids

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THE introduction of chlorine to the crude sewage at the entrance to, or ahead of, clarification tanks for the purpose of disinfection on the one hand, or correction of odors from sprinkling filters on the other, raises the question as to what effect pre-chlorination of sewage exerts upon the subsequent digestion of the settled solids.

In answer to this question it may be said that the information available from plants in which the influent to settling tanks is being chlorinated indicates that chlorination does not interfere with the operation of the digestion processes and, if anything, seems to be an aid to normal digestion. Such reports as are obtainable shed very little light, however, upon the difference in behavior of the digesting solids settled from chlorinated and unchlorinated sewage. To answer the question more fully, therefore, we must turn to laboratory experiments that permit a comparison between the course of digestion taken by the chlorinated and unchlorinated solids. It is the purpose of this article to report upon two series of experiments that were carried out on samples of sludge obtained from the sewage-works of Schenectady, N. Y., where pre-chlorination of sewage for odor and fly control is being studied on a plant scale. The plant studies at Schenectady have been discussed in *Engineering News-Record*, Aug. 11, 1927, p. 229.

Experimental Methods—On two occasions, with a period of 44 days intervening, parallel samples were taken for purposes of experimentation, one from an Imhoff tank operating without chlorination, the other from an adjacent tank the influent of which was receiving a dose of 10 p.p.m. of chlorine. (The experimental technique used by the authors is fully described in *Journal* Boston Soc. C.E., Vol. 14, 1927.) This dosage was intentionally increased to an excess of that normally required for either disinfection or odor control and was sufficient, at the time of sampling, to leave a chlorine residual of 1.5 p.p.m. at the outlet of the tank. The samples were collected by suspending several buckets over the slots for 24 hr. and then preparing a proportioned, composite sample of the solids collected. The samples were shipped during cold weather to the Laboratory of Sanitary Engineering at Harvard University, and experiments upon their digestion characteristics were begun within 48 hr.

TABLE I—ANALYSES OF SAMPLES OF CHLORINATED AND UNCHLORINATED SLUDGE

	Series I		Series II	
	Unchlorinated	Chlorinated	Unchlorinated	Chlorinated
Date of collection	Feb. 15, 1927		March 30, 1927	
Per cent solids	6.10	4.58	7.77	7.46
Per cent water	93.90	95.42	92.23	92.54
Per cent loss on ignition	64.7	64.9	59.6	63.3
pH	5.6	5.7	5.2	5.4

The samples of fresh sewage solids were seeded with well-digested sludge in a ratio of about 1¼ parts of fresh sludge to one of well-digested sludge on the basis of organic solids in each. The sludge used for seeding was obtained from the Fitchburg (Mass.) Imhoff tanks and analyzed as follows in percentages: solids, 15.9; water, 84.1; loss on ignition, 29.1. The pH value was 7.2. The sludge had all the characteristics of a well-digested sludge.

after their collection. Analyses of the samples are shown by Table I.

Methane production and hydrogen-ion concentration were used as the criteria of digestion. The amounts of methane evolved from the beginning of the experiment were measured and are plotted in the accompanying figure against the time elapsed. The slope of the curves thus obtained indicates the rate of gas production at any given instant. Since reaction is such an important factor in digestion, the changes in pH of the sludge mixtures prior to and during digestion are recorded in Table II.

As seen in the figure, the general course of digestion for each pair of samples was quite similar in both series. During the first three or four weeks the chlorinated sample gasified at a more rapid rate than did the unchlorinated sample. At the end of this initial period, however, the rate of methane production by the chlorinated sample slowed down, whereas that of the unchlorinated sample speeded up. At the end of four and six weeks respectively the gas curves of the unchlorinated samples passed those of the chlorinated ones and continued at steeper slopes until the end of the experiment. Turning to the variations in pH of the digesting sludges, it is seen that the chlorinated solids maintain themselves initially at slightly higher values than did the unchlorinated ones. Well-stabilized sludges were produced in both cases.

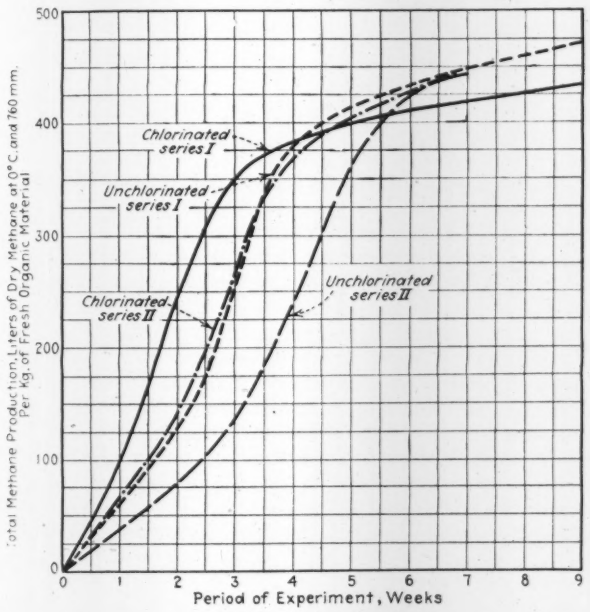
Discussion of Results—It appears that pre-chlorination of settling sewage results in more rapid gasification during the initial stages (four to six weeks) of digestion, but that the ultimate yield of methane is slightly lower. These facts are conceivably due to the following causes: (1) Chlorination stabilizes the finely divided, colloidal or dissolved organic material which is subject to most rapid fermentation and which is probably responsible for the quick initial drop in pH commonly experienced in the digestion of sewage sludge. Thus, since slight variations in pH will produce marked differences in the rate of digestion, chlorination, by keeping the pH slightly higher, would result in more rapid initial methane production. At the same time, however, pre-chlorination did slightly reduce the ultimate yield of the chlorinated sludge. (2)

TABLE II.—HYDROGEN-ION CONCENTRATION OF THE DIGESTING SLUDGES

Temperature maintained uniformly at 20 deg. C.

Series I			Series II		
Elapsed Days	Unchlorinated pH	Chlorinated pH	Elapsed Days	Unchlorinated pH	Chlorinated pH
0	6.4	6.5	0	6.0	6.4
1	6.3	6.4	1	6.0	6.4
3	6.3	6.5	2	5.9	6.4
5	6.3	6.4	3	6.0	6.3
7	6.5	6.5	4	6.1	6.3
10	6.6	6.7	5	6.2	6.2
13	6.7	6.8	7	6.1	6.3
17	6.7	6.8	9	6.2	6.5
24	6.7	6.9	11	6.5	6.6
31	6.8	6.7	14	6.5	6.8
38	7.0	6.9	18	6.8	6.8
45	7.0	6.9	20	6.8	6.8
52	6.9	6.9	23	6.8	7.0
59	7.0	7.0	30	6.8	7.0
66	7.0	7.0	34	7.0	
68	7.2	7.0	37	7.0	7.0
			44	7.1	7.0
			49	7.1	7.1

Chlorination may cause the coagulation and precipitation of finely divided, colloidal or dissolved organic matter that does not settle out in ordinary sedimentation. This, being easily digestible, would increase the initial rate of gas production. (3) Chlorination destroys much of the life associated with fresh sewage solids. Thus the acid-producing organisms and great numbers of other aërobic bacteria and protozoa which *probably* impede or inhibit activity of the methane-producing organisms in the digesting sludge would be largely eliminated. This would result in more rapid digestion and methane production in the early stages of the process. The second possibility may seem contrary to the first idea, but is supported in part by the analyses of the sludges, which show a slightly greater organic content for the chlorinated materials. The more rapid initial gasification, however, may be due to a combination of all three of the factors named.



METHANE PRODUCED BY CHLORINATED AND UNCHLORINATED SEWAGE SOLIDS DIGESTING AT 20 DEG. C.

The slope of the curves indicates the rate of gas production at any given time.

The authors are indebted to Morris M. Cohn, superintendent of sewage disposal, Schenectady, N. Y., for his co-operation in collecting the samples of sludge.

Odor Control by Chlorination at Independence, Kan.

Pre-chlorination at Cost of $3.32 per M.G.D. Effective at Sewage-Works Consisting of Tanks and Sprinkling Filters

By Glen H. Hackmaster
City Engineer, Independence, Kan.

APPLICATION of chlorine to the crude sewage of Independence, Kan., during the summer of 1927, eliminated the odor trouble current for several years past. The average quantity of chlorine required to produce operation without nuisance was 3.32 p.p.m. Pre-chlorination was found to be more effective than post-chlorination.

The sewage of Independence, a city of 15,000 people, is treated by Imhoff tanks, sprinkling filters and secondary settling tanks. The sewage reaches the plant through two outfall sewers converging ahead of a "wet well," from which it is lifted to the adjacent Imhoff tanks. The average flow is 1 m.g.d. The plant was put in use in May, 1924. Before many months of operation we were besieged with complaints of odors from many sections of the city. The odor seemed to be most noticeable in the late afternoon and early evening. We were therefore forced to bypass the sprinkling filters during the night. Although the plant apparently was functioning properly, bypassing the filters seemed to reduce the odor nuisance, so this procedure was continued every summer until July 1, 1927.

Experimental work, begun July 1, 1927, showed that chlorination stopped the odors. Likewise it appeared that certain improvements in plant conditions should effect a reduction in the chlorine required. Deposits of solids in the corners and center of the square "wet well" were causing a somewhat septic sewage. The cleaning of this well was laborious and time consuming. In the center of the well a brick and mortar "island" was constructed. Thereafter, the sewage entered at one corner of the well and the current around the sides materially reduced the deposition of solids. The result was a fresher crude sewage having a lessened chlorine demand at the point of chlorination, which was near the intake of the pump suction line.

The Imhoff tanks contained the conventional cross-baffles at the inlet and outlet ends of the flow chambers. Tests indicated that the incoming sewage, diverted in a downward direction by these baffles, flowed the length of the tank well, beneath the liquid surface, and rose behind the outlet baffle. The liquid displacement was poor, the upper strata were dead and the fresh sewage was sweeping out foul liquor from the lower part of the flow chambers. To remedy this, openings were cut through the cross-end-baffles so that the sewage flowed across the tank near the surface. Wooden "stilling" baffles were constructed across each flow-chamber at the center point. These extended downward to a point 6 ft. below the liquid surface and were constructed of 4-in. boards spaced 1 in. apart, with the end boards flush against the vertical septum walls, thus resembling a picket fence. Wooden scum boards prevented floating material from entering the siphon chamber. This arrangement produced a uniform flow of *fresh* sewage across the tanks and an effluent containing a very small quantity of suspended solids. The effluent was there-

TABLE I—RESULTS WITH DECREASING AMOUNTS OF RESIDUAL FREE CHLORINE AS SHOWN BY ORTHO-TOLIDIN TEST

Residual Chlorine, P.P.M.	Average Number of Bacteria per C.C. 37.5 Deg. C. for Chlorine Contact Period in Minutes					Average Number of B. Coli per C.C. for Chlorine Contact Period in Minutes				
	10	15	20	60	Unlimited	10	15	20	60	Unlimited
1.0	390	.....	500	.....	.....	3	.....	0	.....	.....
1.0*	1,300	.....	.....	.....	.....	10	.....	.....	.....	.....
1.0	280	.....	700	.....	160	0	.....	0	.....	0
1.0*	680	.....	480	.....	110	20	.....	0	.....	50
0.7	.....	.....	.....	.....	55	.....	.....	.....	.....	0
0.7*	.....	100	.....	.....	.....	.....	1	.....	.....	.....
0.6	2,400	400	.....	.....	.....	0	10	.....	.....	.....
0.6*	470	.....	.....	.....	70	110	.....	.....	.....	.....
0.5	.....	120	.....	.....	150	.....	0	.....	.....	0
0.5*	.....	285	230	.....	80	.....	10	10	.....	0
0.3	150	.....	300	.....	.....	10	.....	0	.....	.....
0.3*	.....	.....	.....	.....	60	.....	.....	.....	.....	10
0.25	2,200	.....	.....	.....	.....	100	.....	.....	.....	.....
0.2	1,320	185	1,150	.....	.....	170	0	275	.....	.....
0.2*	100	.....	140	.....	1,300	10	.....	0	.....	50
0.1	5,300	2,800	.....	.....	.....	375	3,400	.....	.....	.....
0.1*	400	85	.....	6,600	.....	55	0	.....	1,000	.....

* Especially accurate results obtained from separate analysis of macerated settled solids and supernatant liquor.

after much less impregnated with the septic liquid from the lower zone of the flow chamber and the hydrogen sulphide in the effluent was reduced, which in turn allowed for a reduction of chlorine applied. Even so, the hydrogen sulphide content of the unchlorinated effluent was frequently above 3 p.p.m.

After the changes were completed, chlorine was applied in the "wet well" as before. Application was begun at the rate of 30 lb. per 24 hr. and gradually increased to 70 lb. and its effect upon the sewage checked by determinations of hydrogen sulphide concentration at various points throughout the tanks and in the effluent. The concentration of hydrogen sulphide in the effluent decreased with increasing chlorine dosage. Reducing the hydrogen sulphide content of the effluent to less than 1 p.p.m. reduced the odors from the filters sufficiently to prevent nuisance. Larger dosages of chlorine were even more effective, but such refinement in operation was considered neither necessary nor economical.

Later it was shown to be good practice to vary the rate of chlorine application during the 24-hr. period. During the day and after 11 p.m. a rate of 30 lb. per day was found satisfactory. From 4 p.m. to 10 or 11 p.m. the rate was increased to the maximum, 70 lb. per 24 hr. This dosage gave residual chlorine in the tank influent after 6 p.m. Thereafter, during the odor period, residual chlorine to the extent of 0.5 p.p.m. was maintained in the influent crude sewage. During all other periods no attempt was made to secure residual chlorine in the influent. No attempt was ever made to secure residual chlorine in the tank effluent.

Experimental work was next conducted, applying the chlorine to the tank effluent. More chlorine was consumed, more hydrogen sulphide was found in the chlorinated sewage, and odor reduction was not satisfactory, so pre-chlorination was adopted as the permanent operating procedure.

On July 20 the plant was turned over to the plant operator, who kept accurate records of sewage pumped, chlorine applied, atmospheric conditions, odor intensity, and complaints. During the periods when the sewage was much diluted by infiltration or leakage, or when the wind blew away from the city, the chlorine was completely shut off. At other times the chlorine was applied at a rate of 25 to 40 lb. per 24 hr. from 11 p.m. to 4 a.m., and raised to 40 to 80 lb. per 24 hr. between 4 a.m. and 11 p.m. The average flows of sewage and chlorine dosage recorded in routine operation were:

Period	Rate of Flow M.G.D.	Chlorine Dosage, P.P.M.	Residual Chlorine, P.P.M.
8 a.m. to 4 p.m.	1.2	3.2	0.0
4 p.m. to 11 p.m.	0.85	10.5	0.2
11 p.m. to 8 a.m.	0.65	6.0	0.0-0.5

Cost of Chlorination

The cost of chlorination depends largely upon the conscientiousness of the plant operator. The degree of freshness of the sewage reaching the plant has an important bearing on the chlorine demand of the crude sewage. The condition of the pump sumps scattered over the sewer system and the condition of the tanks have a great effect upon the chlorine requirement. A dirty plant or sewer system in which solids are permitted to accumulate and become septic will result in increased chlorine demands. Finally, the operator should be alert to take advantage of shifts in wind direction or other effects which may warrant reduction of chlorine applied.

At Independence the average chlorine consumption for the 56-day test period was 27.7 lb. per 24 hr. An average sewage flow of 1 m.g.d. was treated, making a satisfactory dosage of but 3.32 p.p.m. Chlorine delivered

TABLE II—SEWAGE CHLORINATION RESULTS WITH DECREASING CHLORINE DOSAGE

Chlorine Applied, P.P.M.	Average Number of Bacteria per C.C. 37.5 Deg. C. for Chlorine Contact: Screened Sewage Not Chlorinated	Period in Minutes 5	10	15	20	60	Unlimited	Average Number of B. Coli per C.C. for Chlorine Contact: Screened Sewage Not Chlorinated	Period in Minutes 5	10	15	20	60	Unlimited
20.3*	9,200	.....	100	.....	140	.....	.....	100	.....	10	.....	0	.....	.....
16	3,400	350	.....	120	.....	.....	160	2,000	5	.....	0	.....	.....	0
16*	.....	900	120	.....	.....	.....	85	.....	220	10	.....	.....	.....	0
15	32,000	1,700	.....	.....	.....	.....	50	10,000	55	.....	.....	.....	.....	0
15*	.....	3,100	1,300	.....	.....	.....	85	.....	38	10	.....	.....	.....	0
14	28,000	600	380	190	.....	.....	75	4,700	55	3	0	.....	.....	0
14*	130,000	3,600	3,400	4,400	1,500	.....	80	30,500	2,700	1,100	300	650	.....	0
13	5,800	500	550	.....	800	.....	65	3,400	70	22	.....	0	.....	0
13*	2,100	76,000	600	.....	.....	.....	95	1,000	150	65	.....	.....	.....	55
12.5	3,100	.....	125	.....	275	.....	.....	4,000	.....	10	.....	0	.....	.....
12	13,000	550	2,400	400	.....	.....	55	5,300	37	0	10	.....	.....	0
12*	3,000	4,400	140	.....	85	.....	.....	1,000	3,100	10	.....	0	.....	.....
11	170,000	.....	130	.....	20	.....	.....	10,000	.....	0	.....	0	.....	.....
10	63,000	1,300	.....	.....	.....	.....	330	4,300	700	.....	.....	.....	.....	0
10*	61,000	8,000	3,100	4,800	.....	6,600	1,300	22,000	1,700	700	3,000	.....	1,000	50

* Especially accurate results obtained from separate analysis of macerated settled solids and supernatant liquor.

at the sewage plant, including freight and drayage in both directions, costs $12 per 100 lb. The cost of chlorination was therefore $3.32 per 24 hr. or p.m.g. If the plant were larger, the purchase of chlorine in multi-unit car-lot shipments would reduce the cost to less than one-half the present cost.

The results of the test period have been highly gratifying. We have made a canvass of the neighborhood troubled by odors and have found no person willing to file a complaint since chlorination was started. Independence will continue chlorination as part of the routine plant operation during periods of odor nuisance.

Acknowledgment is due Ernest Boyce, chief engineer, and staff, State Department of Health, for the services rendered the city in solving this odor problem. The Chlorine Institute supplied the initial shipment of chlorine and the Wallace & Tiernan Company the chlorinator. L. H Enslow, of the Chlorine Institute, arranged for the experiment and offered valuable suggestions during the experimental period.

* * * *

Chlorination of Screened Sewage at Bridgeport, Conn.

State Health Department Studies Show Need of 10 to 15 P.P.M. of Chlorine and Frequent Ortho-Tolidin Tests

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THE Connecticut State Department of Health has been interested in chlorination of screened sewage, particularly in view of the large fine-screening plant at Bridgeport, Conn., and the possibility of other installations where chlorination would be an added safeguard to bathers. As a method of complete treatment, fine screens and chlorination have probably a limited field of usefulness, since fine screens remove a rather low percentage of suspended solids.

The Bridgeport screening plant consists of two Riensch-Wurl screens with $\frac{3}{64}$-in. slots. The present flow is about 8 m.g.d. The sewage is of medium strength as compared with that of other Connecticut cities. It is affected by considerable amounts of factory wastes and by infiltration of large amounts of salt water at high tide.

A tap was made in the force main from the pumps discharging the screened sewage to the harbor. A short length of pipe arranged with a minimum number of bends and interferences to further break up the solids carried the sewage to two barrels with inlets and outlets suitably arranged for a constant flow of sewage past the experimental chlorination plant and through the barrels. To cover the variations in the character of the sewage, half-hourly test runs of about 8 hr. were made on fourteen days extending over the period from October, 1926, to April, 1927. Sunday as well as week-day flows were represented to avoid inclusion of the factory wastes, and all conditions to tidal variations were covered. Bacterial examinations were made of 153 sets of samples, each set comparing the chlorinated with the unchlorinated sewage. Occasional abnormally low bacterial counts on the unchlorinated sewage are undoubtedly due to the germicidal effect of occasional discharges of industrial wastes.

The experiments were made to obtain information on the following questions: (1) Penetration of the solids in the screened effluent by the chlorine, (2) period of contact required, (3) effectiveness of ortho-tolidin control, (4) approximate dosage required for Bridgeport screened sewage.

The method of determining the penetration of the solids by the chlorine was to settle for two hours in Imhoff cones the screened and chlorinated sewage, remove samples of the supernatant liquor and the settled sludge to separate bottles, then thoroughly macerate the solids with pestle and mortar and examine the emulsion bacteriologically.

The contact period between chlorine and sewage was controlled by the addition of enough sodium thiosulphate to samples of the chlorinated sewage to destroy any residual chlorine and chlorine substitution products and insure a tenfold excess of thiosulphate. Experiments have demonstrated that this addition of sodium thiosulphate has no inhibiting effect upon the growth of bacteria at the usual temperatures. Intervals of contact with chlorine of 5, 10, 15, 20, 25, 30, 40 and 60 min. were employed, and some samples represented unlimited contact, varying from several hours to 24 hr.

Tests for free chlorine were made with ortho-tolidin and by the starch-iodide method upon chlorinated samples corresponding to those examined bacteriologically. The starch-iodide test did not appear to be so useful quantitatively as the ortho-tolidin test, although when used with acetic acid it was of value in detecting the presence of chlorine, which is apparently held in loose combination with organic matter and, therefore, probably becomes slowly available. The readings for free chlorine (Table I) represent the maximum color produced by adding 1 c.c. of ortho-tolidin to samples of sewage in 1-oz. bottles. Where 0.3 p.p.m. of residual chlorine was present after a 10-min. contact, fairly satisfactory bacterial results were obtained.

As indicated by Tables I and II, where chlorine concentrations were too low, higher bacterial results followed examination after maceration of solids, due presumably to breaking up clumps of bacteria. The results indicate a penetration of these clumps by the chlorine, since with sufficient dosage and contact the analyses are satisfactory when the chlorine has been neutralized and the clumps have been broken up. Both tables show that little improvement occurs by providing a longer period of contact than 10 min. where sufficient residual chlorine is present. Some of the figures showing longer periods of contact and low dosages were omitted from the tables, because of less relative significance.

Table II shows that a dosage of 15 p.p.m. (125 lb. per m.g.) was required to produce acceptable results during the periods covered for the Bridgeport sewage. Assuming a cost of 7.5c. per lb., this would amount to $9.38 per m.g., but if chlorine were purchased in ton containers the cost could be reduced to about 4.5c. per lb., or $5.63 per m.g. On certain days it was possible to secure satisfactory results with lower dosages.

The results of the work to date at Bridgeport seem to warrant the following conclusions:

1. For effective and dependable disinfection of the Bridgeport fine screen effluent, 0.3 p.p.m. of residual chlorine after a period of 10 min. was required. A residual of 0.5 p.p.m., however, is preferable. A 15-min. period of contact may afford some slight improvement, but beyond that it does not seem necessary to go, provided the proper residual is maintained.

2. When 0.3 p.p.m. of residual chlorine and 10 min. contact were provided, the suspended solids were effectively penetrated and the colon bacilli were satisfactorily reduced within the solids passing $\frac{3}{64}$-in. openings in fine screens.

3. The chlorine dosage required to effect a residual of 0.3 p.p.m. after 10 min. varied in the case of the Bridgeport effluent between 10 and 15 p.p.m. The upper limit was necessary to take care of all conditions covered, but such requirements will vary for different sewages and doubtless for the same sewage at different seasons of the year.

4. If satisfactory efficiency of chlorination of sewages is to be held at a minimum cost, chlorine control by the ortho-tolidin test should be made as frequently as practicable.

It must be borne in mind, however, that the character of the effluent from a fine-screening plant changes rapidly over short intervals of time and changes in rates of dosage below the upper limit must be carried out with due regard to this fact.

The writers wish to express their appreciation of the advice and assistance of L. H. Enslow of the Chlorine Institute, and the co-operation of the Bridgeport city officials, in making this work possible.

Foundation Plans Changed After Water Enters Excavation

When Water Inflow Softened Hardpan, Piers Were Carried to Underlying Rock by Pneumatic System

By W. S. Wolfe and D. R. Martin

Head of Structural Department, Smith, Hinchman & Grylls. Superintendent, Smith, Hinchmann & Grylls.

Detroit, Mich.

UNUSUAL foundation conditions and methods were involved in the construction of the Greater Penobscot Building, at Fort and Griswold Sts., Detroit, Mich., a structure which will be 565 ft. high and will have foundations designed to support approximately 100,000 tons. There is to be a large banking room on the second floor, over which the office floors will be carried by girders about 45 ft. long. The columns which support these girders deliver foundation loads of over 2,500 tons each.

As originally designed and contracted for, the foundations consisted of open wells or caissons having large bells at their bottoms resting on hardpan at about 120 ft. below grade, the large area of the bell giving a maximum load of 8 tons per square foot. Previous experience in Detroit indicated that caissons could be put down to hardpan by the open well method without any serious water difficulties, but that if an attempt were made to go through the hardpan to rock a short distance below, sulphur water under a head of approximately 110 ft. would be encountered. It was because of this serious water condition that the foundations were not designed for rock in the first place. [Foundation work in this sulphur-water stratum was described in *Engineering News-Record*, Sept. 15, 1927, p. 424, but in that case open wells were used instead of the pneumatic system.—Editor.]

Work progressed rapidly on the job until the hardpan was reached in the first well, 6 ft. 9 in. in diameter, and the bell was more than half excavated, when water rushed in from the side and bottom, apparently through an opening or crack in the hardpan. Within twenty minutes the water had risen 10 ft. and in twelve hours it was 100 ft. deep in the caisson. It was considered inadvisable to attempt to pump out such a large flow of water, for fear that this might cause settlement of adjoining buildings. Furthermore, the hardpan is somewhat softened and broken up by the water, making it doubtful if a good bottom could be obtained with so much water present. It was therefore decided to omit the bells, use compressed air and push the caissons down to rock. The general foundation arrangement, with a section at one of the bore holes, is shown in Fig. 1.

The necessary equipment was obtained but work was slowed up by the high head of water and the high air

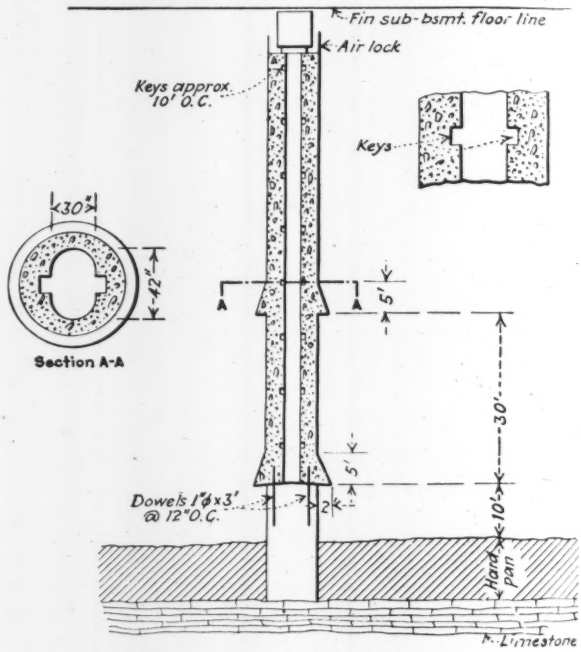


FIG. 1—FOUNDATIONS FOR DETROIT BUILDING

pressure required to combat it, a maximum pressure of 51 lb. per sq.in. being required. Even with this high pressure considerable amounts of water came into some of the wells. This water was ejected by the use of a small pipe extending from the bottom of the well up past the air lock to the top. The air pressure in the caissons was sufficient to force the water, with a certain amount of air, through this pipe and out over the top of the well.

In putting down a caisson or well, the method of procedure was as follows: First, an open well was put down somewhat more than half way to rock. In this well a concrete shell was poured, its outside diameter being the size of the caisson and the shaft inside being large enough for the passage of men and materials. Two collars or small bells were cast on this shell, one at the bottom and the other a number of feet higher up. This is shown typically in Fig. 2, but the dimensions varied in different shafts. After the concrete of the shell had set, the air-lock was bolted on its top and the excavation continued below the shell, air pressure being put on as required. The small bells or collars prevented the shell from slipping down when excavation was continued below it. They also helped to prevent the air from forcing the shell upward when a high pressure was required. After rock was reached, the well below the shell was filled with

concrete, and when this had set the shaft inside the shell was also filled, making a solid concrete shaft or pier from top to bottom.

It was found that a large part of the water came up through cracks in the rock; and there was some concern regarding the effect of the sulphur water on the concrete caissons. The decision was therefore made to sink 6-in. well casings from the ground level down to rock and then drill with a well driller into the rock until a flow of sulphur water was encountered. Cement grout was then forced down the well casings and into the cracks in the rock under pressures as high as 125 lb. per square inch. It took 388 sacks of cement to fill the crevice tapped by one of the holes, and several took as many as 200 sacks. In all 1,846 sacks of cement were used in the eight grout holes.

These grout holes were distributed as evenly as possible around the job. The grouting was successful in reducing the amount of water encountered and permitted the maximum air pressure to be greatly reduced. The saving in cost by being able to put the wells down with

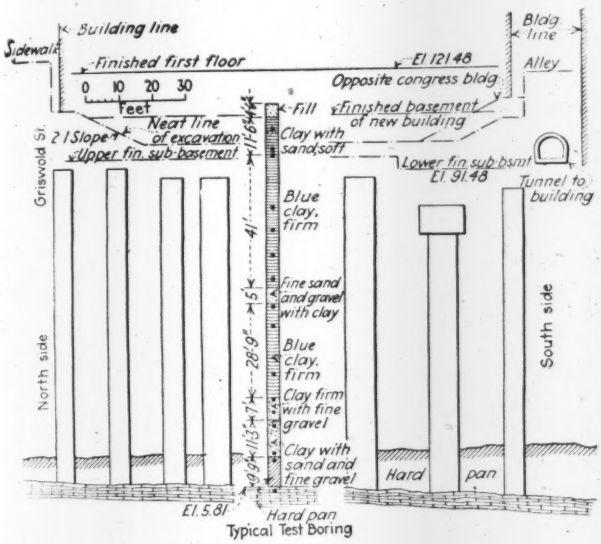


FIG. 2—TYPICAL FOUNDATION WELL FOR PIER
Note shell from air lock to shaft, with collars to anchor it in position.

a lower air pressure, and the consequent saving in time, more than offset the cost of the grouting operation. It is also felt that with the cracks in the rock sealed by the grout, there is less danger of the sulphur water disintegrating the concrete of the piers.

One of the interesting features in this foundation work was the high strength of concrete. Concrete of at least 3,000 lb. ultimate strength was specified, but many of the test specimens ran over twice this strength and the average of all 28-day breaks was more than 5,000 lb. per square inch. Of 188 cylinders broken at 28 days, the highest and lowest strengths were 7,552 lb. and 2,830 lb. for 167 cylinders broken at seven days, the highest and lowest figures were 6,049 lb. and 1,539 lb. The averages were 5,286 lb. for the 28-day and 3,683 lb. for the 7-day breaks.

An inundator was used for a large percentage of the concrete poured, but toward the latter half of the job, because of interference, all concrete could not be advantageously poured through the inundator plant and two additional batch mixers were used. From a careful check of materials and results from both methods it was found that the same results could be obtained without the inundator plant by proper design, supervision and care. However, the use of the inundator did reduce the chance for error and the required supervision. The time of mixing averaged about two minutes per batch. A total of 9,820 cu.yd. of concrete was poured and 70,929 sacks of cement were used for this concrete, or a grand average of 7.222 sacks per yard of concrete.

TESTS OF FOUNDATION CONCRETE

28-day cylinders			7-day cylinders		
Break, Lb. Per Sq. In.	No.	Per Cent	Break, Lb. Per Sq. In.	No.	Per Cent
7,000 and over	5	2.7			
6,000 to 7,000	37	19.7	6,000 and over	2	1.2
5,000 to 6,000	78	41.5	5,000 to 6,000	10	6.0
4,000 to 5,000	55	29.2	4,000 to 5,000	41	24.6
3,000 to 4,000	11	5.9	3,000 to 4,000	80	47.9
3,000 and below	2	1.0	2,000 to 3,000	32	19.1
			2,000 and below	2	1.2
Total	188	100.0	Total	167	100.0

The Greater Penobscot Building is being built by the Simon J. Murphy Company. Smith, Hinchman & Grylls, Detroit, are the architects and engineers, with Donaldson & Meier as advisory architects. Walbridge-Aldinger & Company, Detroit, had the contract for the foundations.

Explorations in Alaska

The Interior Department announces the completion of the field work of another exploratory expedition in Alaska by the Geological Survey and the bringing back of maps and information regarding a tract of more than 2,000 square miles in the Alaska Range and adjacent country on the west side of Cook Inlet, in the environs of Mount Spurr, that has hitherto been shown as a blank area on all authoritative maps. This exploration is one of the series that the Geological Survey has been making throughout the last 30 years. The party consisted of S. R. Capps, geologist in charge, R. H. Sargent, topographic engineer, and four camp men. Transportation in the field of the necessary provisions, supplies, and equipment for 100 days was furnished by a pack train of fifteen horses. From the time when the party landed at Trading Bay, on the west side of Cook Inlet, about the middle of June, until it returned to that place at the end of the field season, about the middle of September, the members were entirely out of communication with the rest of the world and saw no human beings other than one another. The results of the expedition are now being worked up for publication, but as it will be many months before the reports are completed, it may be of present value to give in advance a statement of some of the notes of greatest general interest regarding the work of the party. Among the many items reported are the discovery and mapping of a large river, numerous lakes, glaciers, and mountains, and an active volcano. The newly discovered river is the Chakachatna, whose drainage basin covers an area of more than 1,100 square miles. This stream is a roaring torrent far too swift and too deep to be forded even with horses; in fact, measurement of its current at several places showed that it was flowing at an average speed of 15 miles an hour. This river rises in Lake Chakachamna, 23 miles long, which is hemmed in between lofty mountains and impounded behind a great glacier that lies athwart the general trend of the valley.

SECOND OF TWO ARTICLES—

Tunneling at Musconetcong Now and Fifty Years Ago

Comparison of Tunneling Methods Employed in 1874 with Those of Today on Virtually Identical Tunnels for the Lehigh Valley R.R.

The first article comparing the tunneling methods employed in the new Musconetcong tunnel with those used in the old tunnel appeared in Engineering News-Record, Dec. 22, 1927, p. 988.—EDITOR.

INGERSOLL drills were selected at old Musconetcong as representing rock drill design in about its highest development. This drill had been put on the market by Simon Ingersoll in 1870. A section of the drill, from an illustration of the period, shows its main characteristics. It has a 5-in. piston, which indicates altogether a pretty sizable and hefty contrivance, but it was selected because, among other reasons, it was lighter and handier than the older Burleigh drills used at Hoosac and at Nesquehoning. At new Musconetcong the drills are Lyner-Ingersoll drifters—R 72, weighing 164 lb. Direct comparison is impossible because a change of principle is represented—the old drill is a piston drill; the new is a water hammer drill. Roughly, the new drill is eight times as fast and requires half as many man-hours for shifting.

On the old tunnel all drills, both for bench and heading holes, were carriage-mounted, the practice and the general design of the carriages being taken directly from the Hoosac tunnel work. Sketches from old records indicate the drill mountings and the drill-hole arrangement. In the new tunnel the drills are mounted on columns for the heading holes and on tripods for the bench holes. A view in the new tunnel heading and the drill-hole arrangement are given by the illustrations. Comparing the number, depths and footage of holes, they were for heading in the old tunnel as follows:

Designation	Number	Depth Ft.	Total Footage Ft.
Cut C	12	10½	126
First square-up (1)	8	12	96
Second square-up (2)	8	12	96
Third square-up (3)	6	12	72
Extra roof holes	2	10 & 8	18
Total	36		408

The roof holes were drilled only when needed. In the new tunnel the heading holes proper, were:

Designation	Number	Depth	Total Feet
Rib holes (*R*)	10	11	110
Relievers (*Re*)	18	11	198
Lifters (*L*)	8	11	88
Cut holes (*C*)	6	13	78
Total	42		474

Adding the 7 down-holes *D* used only when necessary to break down the top edge of the bench and drilled in the heading round, we have $7 \times 6 = 42$ ft., making the total footage 516 ft. In the old tunnel the bench drilling comprised 6 down-holes 12 to 13 ft. deep, a total, say, of 72 ft., and 4 toe-holes 10 ft. deep, making a grand total of 112 ft. of bench drilling. In the new tunnel the bench drilling comprised 20 bench-holes 11 ft. long and 5 toe-holes 5 ft. long, or a total of 245 ft. Drilling rates cannot be compared with the records, as they are only partial for the old tunnel and incomplete for the new tunnel. Very little, too, has been told of the drill servicing at the old tunnel, but hand-sharpening was employed at an ordinary blacksmith forge and drill conditioning was a process of doing what was necessary only when it was necessary. In comparison, the servicing equipment at the new tunnel as shown by several views stands out in sharp contrast.

Blasting performance like drill performance, and for the same reason, is not in condition for comparison. On the new tunnel, of course, electric firing and dynamite are being employed, with all the recent perfection of cartridges, exploders and electric blasting, and all the modern finesse of delay firing. On the old tunnel it is interesting, then, to note that dynamite and electric firing were used throughout for the first time in tunneling in America. So revolutionary was the practice that contemporary writings on the old tunnel work enter into elaborate argument defending it. Indeed, the accomplishment of dynamite at old Musconetcong deserves notice; for 82,000 cu.yd. excavated the average was 1.71 lb. of dynamite per cubic yard.

Timbering and Mucking—Timbering was a particular problem in both tunnels in the soft ground and, to a less extent, in loose rock. In the seamy rock at the east end of the new tunnel where only roof falls had to be guarded against, only a plain segmental timbering was required. The soft-ground problem was much more complex. The ground is very unstable when wet and in the new tunnel workings it developed enormous pressures. Comparable pressures in the old tunnel are not indicated by any of the contemporaneous accounts. Indeed, in the English system of timbering, used in that tunnel generally, all the timbering usually saved was saved, and only occasionally was it found impossible to pull the crown bars ahead. Either of these procedures would be virtually impossible with the pressures existing in the new tunnel workings. Here 16-in. fir segments set close were split and shattered, and 12-in. diameter posts were broken. The normal timbering is 12x12-in. posts and arch segments set close, increased to 12x6-in. posts and segments in heavier ground and in the worst places reinforced by an inner "timbering" of steel beam posts and segments as shown by accompanying drawings.

In the old tunnel the excavation and timbering followed very closely the typical English system, as the drawings make apparent. About 20 ft. of tunnel was excavated to full cross-section and then it was lined; then another length was excavated and the lining was built. As stated before, the process involved no particular complications and apparently required no more than ordinary good care.

In planning the work through soft ground for the new operation it was thought best to drive a crown drift and two wall plate drifts, making enlargement from these drifts, then placing wall plates and segmental roof timber. A power shovel was then to be used to take out

the center of the remaining core down to grade, leaving a bench on each side to support the wall plates. These benches were to be taken out as the plumb posts were erected. The pressures developed soon put a check on the planned procedure and the plan was changed to that shown by the drawings. This gave an opportunity for placing plumb posts, wall plates and bottom arch segments and bracing them against the core. The crown drift similarly gave opportunity for placing, and stulling to the core, the top crown bars. The drifts then left uncompleted timbering only at the haunches, which were then widened out right and left from the crown drift by placing one crown bar after another, stulling them to the core and driving polling-board lugging. Finally, under the crown bars and lagging the remaining arch segments were placed. All processes can be very clearly visualized from the drawings and views; scarcely a detail needs further explanation.

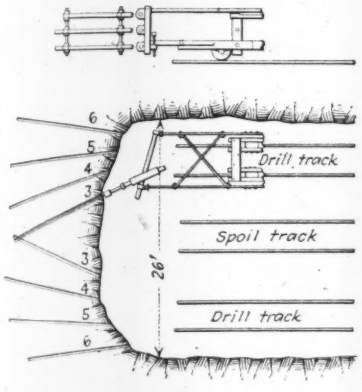
There are in the drifts and core about the following yardages of excavation:

Drifts	Size	Volume per Foot
Crown	12½ x 11½ ft.	5.3 cu.yd.
Wall plate (two)	8½ x 11½ ft.	7.2 cu.yd.
Plumb post (two)	11½ x 10½ ft.	9.0 cu.yd.
Enlargement, both haunches		10.0 cu.yd.
Center core		16.0 cu.yd.
Total		47.5 cu.yd.

All but the core excavation is by hand, the muck being taken out in small push cars, the cores being taken out by a 1½-cu.yd. capacity crawler-traction shovel equipped for air operation. Otherwise the earth mucking methods are like those of the east end in rock where the heaviest mucking has to be done. This core excavation by power shovel is the major distinction, in mucking methods in earth, between the old and the new tunnels.

In rock at the east end, the full excavation was handled by power shovel—the shovel used on the east approach cut changed to operate by compressed air. Two tracks were laid into the tunnel; the shovel was operated on one and the outgoing muck trains on the other. The incoming empty trains came into the tunnel on the shovel track, an air hoist on the rear of the shovel being used to shift the cars to the loading track. At the west end where a crawler-traction shovel is employed, the car shifting is done by gas and electric locomotives, but an improvised traveler carrying an air hoist will be installed. For handling the shovel excavation, the regular 5-cu.yd. dump cars for the open-cut work were used. They were spotted by a 7-ton electric locomotive and hauled to and from the waste dumps by 16-ton gas locomotives.

Lining—In the old tunnel, only the 770 ft. from the



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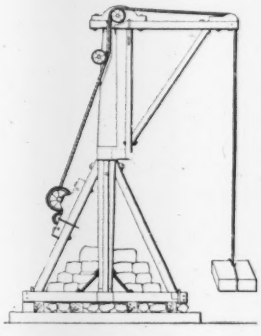

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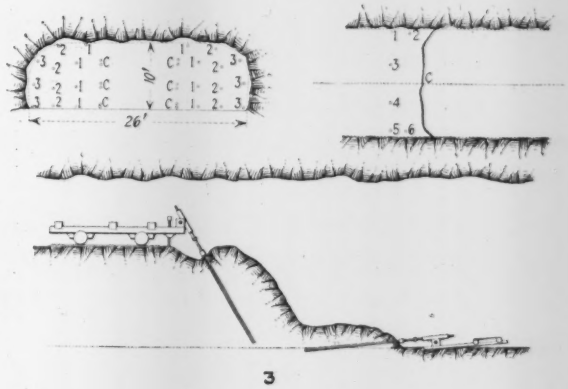

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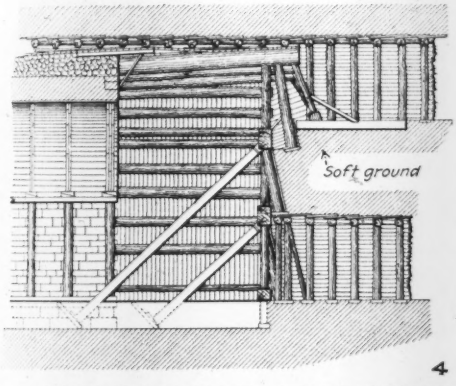

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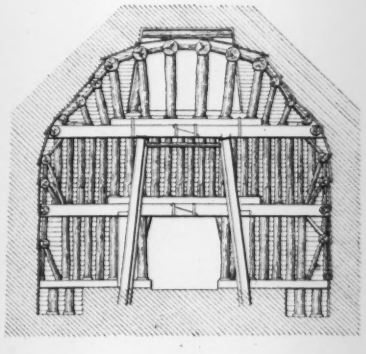

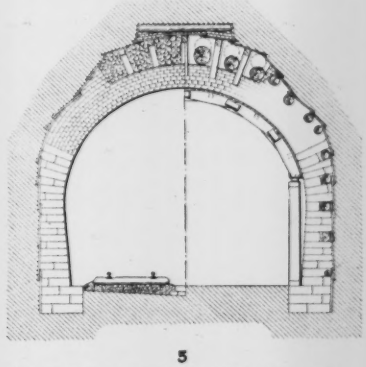

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1—DRILL CARRIAGE FOR HEADING HOLES IN OLD TUNNEL

These carriages, copied from the Hoosac tunnel carriages, were of timber with iron shaft bars. The contractor's mining superintendent, William White, who worked at Hoosac, designed them.

2—HAND DERRICK FOR LINING OLD TUNNEL

This appears to have been the only equipment besides regular masons' tools used in lining the old tunnel.

3—HEADING HOLE DIAGRAM AND BENCH DRILL CARRIAGES ON OLD TUNNEL

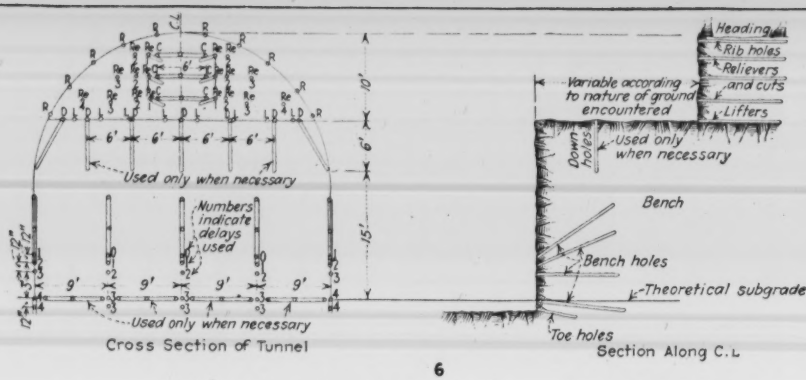
Note the wedge-shaped center cut. William White is credited with having introduced the wedge center cut and subsequent "squaring up" rounds at old Musconetcong.

4—ENGLISH SYSTEM OF TIMBERING SOFT GROUND IN OLD TUNNEL

Short lengths of tunnel excavated and timbered to full section and then lined, in alternate operations, with a starting drift at the crown and a bottom drift for drainage and an additional point of attack, is the typica' "English system" procedure.

5—LINING FOR SOFT GROUND IN OLD TUNNEL

Coursed rubble stone side walls and brick arch all set in Rosendale cement mortar. Compare with new tunnel lining.



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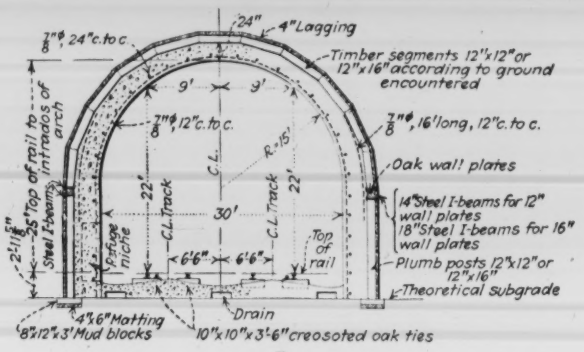

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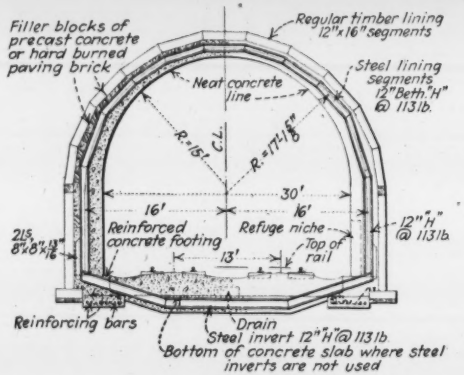
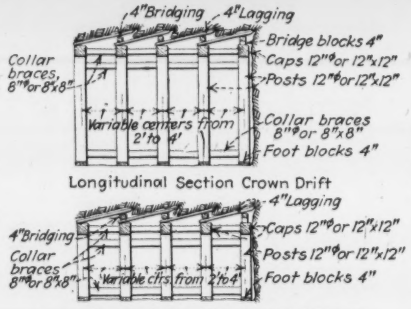
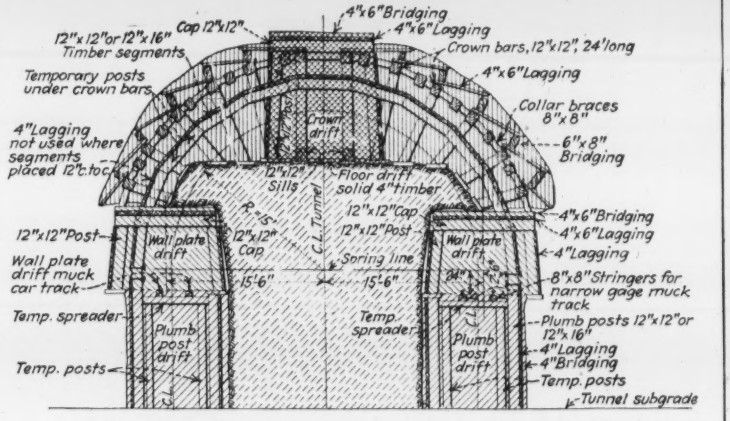

Filler blocks of precast concrete or hard burned paving brick
Regular timber lining 12"x16" segments
Steel lining segments 12"Beth."H" @ 113 lb.
Neat concrete line
Reinforced concrete footing
Refuge niche
Top of rail
12"H" @ 113 lb.
Reinforcing bars
Drain
Steel invert 12"H" @ 113 lb.
Bottom of concrete slab where steel inverts are not used

8





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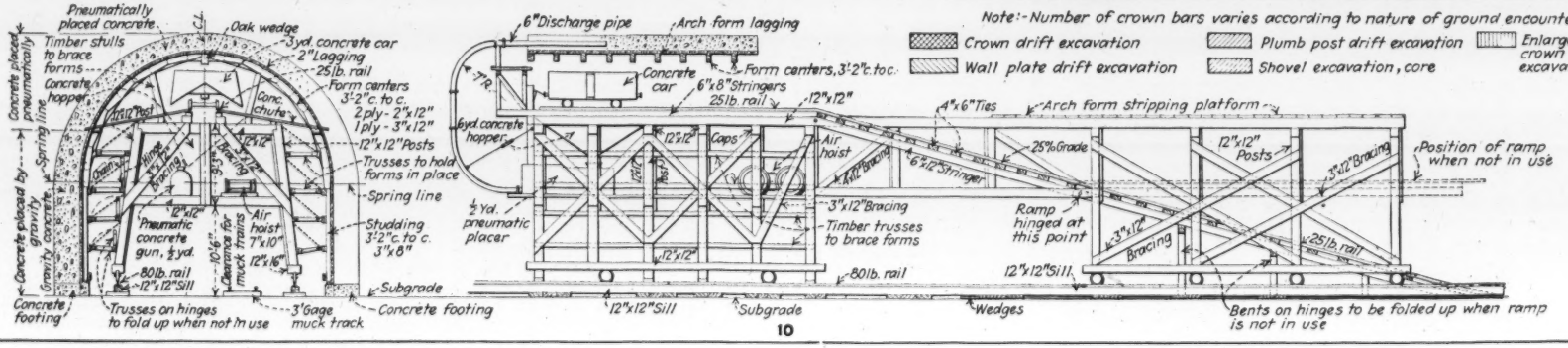

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6—DRILL HOLE DIAGRAM FOR COMPLETE ROUND IN NEW TUNNEL

7—LINED SECTION AND TIMBERING FOR MODERATE PRESSURES, NEW TUNNEL

8—STEEL "TIMBERING" FRAMES FOR VERY HEAVY GROUND, NEW TUNNEL

9—DRIFT AND TIMBER LAYOUT FOR SOFT GROUND, NEW TUNNEL

10—LINING TRAVELER USED ON NEW TUNNEL

FIR ROOF SEGMENTS 16 IN. SQUARE FRACTURED BY EARTH PRESSURE NEW TUNNEL

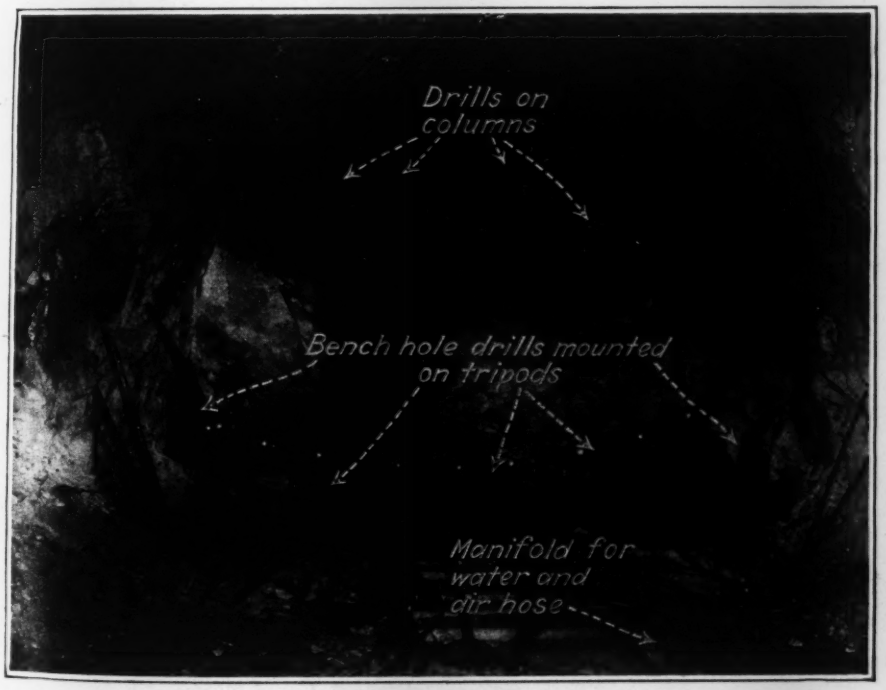
Sawed timbers 12 in. and 16 in. square set touching each other were split and sprung by the earth loads encountered in the new tunnel.

FIR POST UNDER CROWN BAR BROKEN BY ROOF PRESSURE, NEW TUNNEL

This represents a type of failure in the temporary timbering which occurred during excavation for placement of permanent timbering.

west portal in through the soft ground and the 263 ft. through loose rock were lined. The lining was masonry, coursed rubble walls and a brick arch. The sketch in the group drawing also indicates the type of arch centering employed. The mortar was 1:1, of Rosendale cement. Virtually the only equipment, besides masons' tools, used in lining work was the hand derrick illustrated. Two men, it is stated, could raise a ton block of stones with this derrick. That credit may go to an old-time contractor's superintendent, it is mentioned that the derrick was designed by Jacob Snyder, a mason superintendent for Charles McFadden, the contractor.

The lining of the new tunnel is portland cement concrete, of which about 25,000 cu.yd. will be required. Besides the concrete, some 2,500,000 ft.b.m. of timber and 550 tons of steel are required. In 1875, the year when the old Musconetcong tunnel was completed, David O. Saylor put the first American-made portland cement on the market. Probably not 15,000 bbl. a year were produced for the next five years. As a considerable construction material, portland cement concrete has come into being since the first Musconetcong tunnel was completed; and by the same token all concrete-making machinery is new. We have, then, in mixing and placing plants for the new tunnel a type of equipment unthought-of when the old tunnel was lined. This equipment is shown clearly by the drawing and views.



VIEW OF HEADING AND BENCH IN NEW TUNNEL

Note the use of steel screw columns to which the drills are clamped by a universal column arm for drilling face holes. Drills were tripod-mounted for drilling bench holes.

The lining of the new tunnel is shown by several of the drawings, and the notable feature is the steel frames set inside the timbering in heavy ground and embedded in the concrete. Where the steel frames are not used the concrete lining is reinforced. The particular interest of the lining work lies in the mixing and placing plants, which

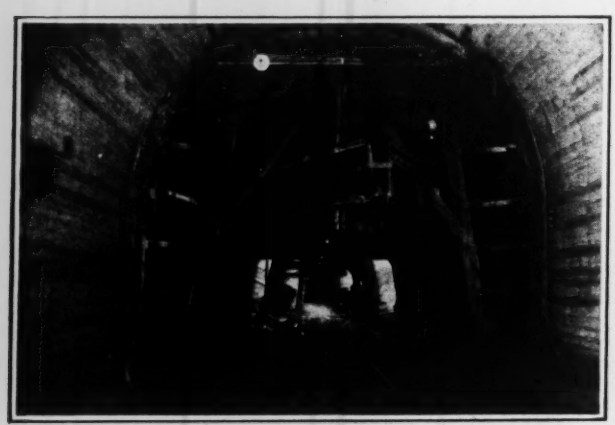
CONCRETE MIXING PLANT AT WEST END OF NEW TUNNEL

Concrete was a rare construction material in the time of old Musconetcong. David O. Saylor in 1875, the year the tunnel was finished, began manufacturing the first portland cement to be made on the American Continent.

are essentially alike at both ends. The drawing shows the mixing plant arrangement at the west end. The arrangement is ordinary; derricks unload from cars into stock-pile or overhead steel batch-measuring bins; a 1-cu.yd. cube mixer is under the bins and right- and left-gate batch cars on surface tracks take the concrete to the tunnel. A 1:2:4 concrete is used for lining.

The notable feature is the manner of placing the lining. Briefly, all but the crown section of the lining is placed by gravity from a traveler and the key section is placed pneumatically by a Ransome 14-ft. pneumatic placer. The general arrangement of the traveler is shown by the drawing. Its functions and operation are amply explained by the legends on the drawings. A traveler is installed in each end of the tunnel.

Direction and Labor—The direction of the old tunnel work included men whose names have since become known in engineering and contracting. Robert H. Sayre was chief engineer, Calvin C. Brodhead was principal assistant engineer, and Henry S. Drinker was resident engineer. The contractor was Charles McFadden of Philadelphia, Pa., who had regularly on the work about 1,000 men who lived, an old account says, in a "settlement of several hundred shanties on each side of the mountain." The men were mostly Irish but at one time the contractor brought up some Virginia negroes and the resulting race riot set a record for pay-day battles—three negroes and one Irishman killed. It is told that "liquor shanties" gave considerable trouble on the old work. Today the contractor has a deputy-sheriff to keep bootleggers off the job. The old work excelled the new in spectacular accidents—less than such going unnoted. Once a boiler blew up and killed three men and on two occasions quantities of the new explosives "went off," and killed no one.



LINING TRAVELER AND FORMS READY FOR OPERATION

This view is at the west end, and is interesting particularly for showing how the forms are braced from the traveler.

The term shanties used above probably tells perfectly the kinds of laborers' camps at old Musconetcong. On the new work the contractor houses about 200 men at each end in substantial bunk houses heated and screened and having bathing facilities, and he has dining halls, camp stores, engineer's and contractor's offices, and all the usual services of a modern construction camp. The lighting is by electricity. Water is piped to sump and job and electric pumps are provided for fire pressures. Job service buildings are equally substantial and comprise sawmills, drill sharpening and blacksmith shops, and cement and store houses all modernly equipped. Aside from the improved construction equipment with which to work, probably no difference between the operations of 1874 and 1927 would appear more astounding to the workmen on the old tunnel than the living accommodations and commissary provided for their kind at the new tunnel.

The new tunnel is being built for the Lehigh Valley R.R., G. T. Hand, chief engineer, and W. H. Ramsey resident engineer on the work. The contractor is Bates & Rogers Construction Co., Chicago, Ill., with R. E. Ross district manager in charge of the work.

Arc Welding Used on One Story Building Two Acres in Area

Field Welding, Shipping 60 Per Cent of Material Direct From Mill to Job, and Continuous Purlin Detail Effect Savings

By Gilbert D. Fish
Consulting Structural Engineer, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

A KILN tunnel building one story high and two acres in area was recently completed at the Derry, Pa., Works of the Westinghouse High Voltage Insulator Co. Apart from bolting for assembly and erection, all connections were made by arc welding. Of the 337 tons of steel, 40 per cent was fabricated, and the balance was shipped plain from mill to job. All welding was done in the field, about three-eighths of it in assembly welding on the ground before erection and the remainder in place after erection. The ground welding could have been done in a shop, and under different circumstances might have been so done.

The contract was awarded at a lump sum of $26,582, the sum of the contractor's estimates, which may be divided as follows:

Plain material, on cars at building	200 tons at	$42.20 =	$8,440
Fabricated material, on cars at building	137 tons at	63.00 =	8,630
Erecting and painting	337 tons at	18.49 =	6,232
Ground welding	858 feet at	1.45 =	1,240
Welding in place	1,402 feet at	.88 =	1,240
Welding sketches and special engineering			800
Contract price			$26,582

Welding Time—The detail of welding time and labor directly connected with welding is given in the accompanying table. In explanation of the columns in the table, "welding" refers to paid hours of work by welding operators other than time spent on moving equipment or on laying out work; the time in the "welding" column includes all time lost waiting for erectors to handle steel to and from the stocks where ground welding was performed, and all other lost time except for moving the welding machines. "Layout" refers to the time which the welding operator who acted as foreman spent on measuring and placing connection angles ready for welding and on supervision and direction of welding operators. "Helping" refers to 252 hours by one man who was employed throughout the job as a general unskilled helper for the welders, and to 146½ hours spent by welding operators and casual helpers in moving equipment and on odd jobs which could not be classed as welding or as layout, but which were connected with the welding operation. The average speed of welding, based on the welding hours shown in the table, was 3.5 lineal feet per hour in the case of ground welding, and 4.2 lineal feet or cubic inches per hour for welding in place. The time records did not distinguish between fillet welding and butt welding, and it should not be assumed that one lineal foot of fillet weld corresponded very closely in time with one cubic inch of butt weld. However, it is believed that the units are roughly comparable, because the 0.6 cu.in. of weld metal in a $\frac{5}{16}$-in. bead 1 ft. long is generally deposited at a slower rate per pound of metal than a simple butt weld deposited downward in a trough.

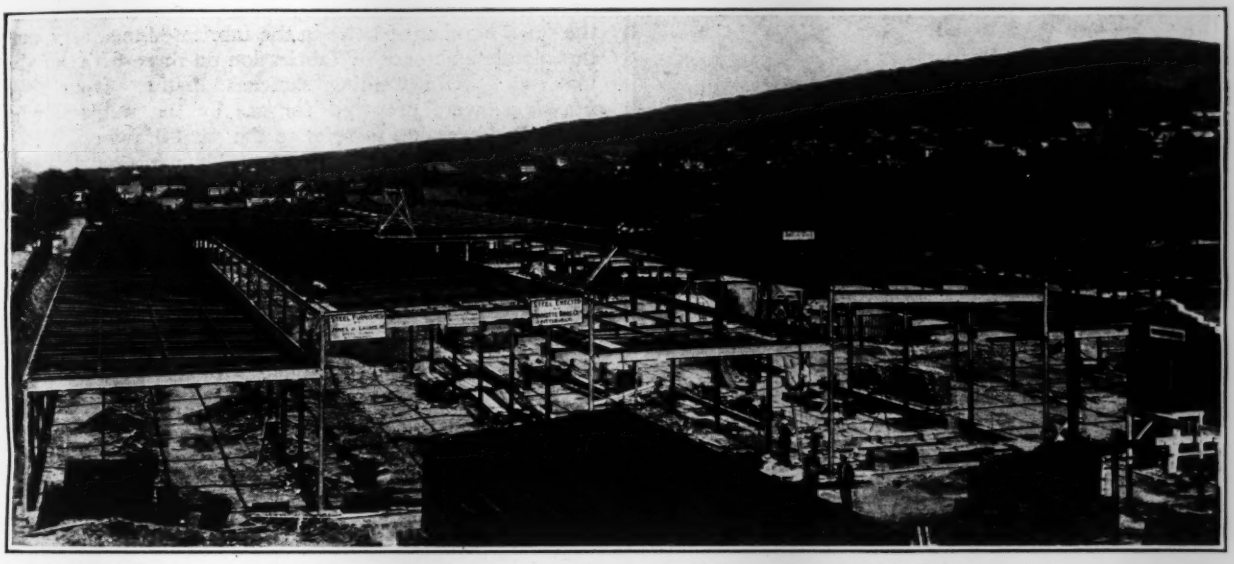


FIG. 1—ARC-WELDED TWO-ACRE BUILDING UNDER CONSTRUCTION

In estimating the time required to perform a job, the basis for butt welding may be cubic inches or pounds, but for fillet welding it should be lineal feet of welds for each size of fillet.

Description of Building—The building is L-shaped, the main body being 460 ft. x 150 ft., and the outstanding leg 142 ft. x 120 ft. The main area has 23 column spaces at 20 ft. the long way, and 5 spaces at 30 ft. the other way. The leg area has three spaces at 30 ft. and one at 52 ft. the long way, and six spaces at 20 ft. the other way. There are, altogether, 133 panels at 20 ft. x 30 ft. and 6 panels at 20 ft. x 52 ft., making the total ground area enclosed by wall column center lines 86,040 sq.ft. The total steel per square foot is 7.83 lb. The steel list

LABOR HOURS ON 2-ACRE 1-STORY ARC-WELDED BUILDING

Location	Hours, Labor — Welding	Laying-out	Helping	Total	Welding Done
On ground	246	143½	261½	651	858 lin.ft. fillet welds, ¼ and $\frac{5}{16}$ in., lengths ½ in. to 4 in.
In place	333½	42	137	512½	1,080 lin.ft. fillet welds, mostly $\frac{5}{16}$ in. in 5 in. lengths; 322 cu.in. butt welds.
Total	579½	185½	398½	1163½	1,938 lin.ft. fillet welds, ¼ and $\frac{5}{16}$ in.; 322 cu.in. butt welds.

is made up almost entirely of 6-in. and 8-in. H-columns, 18-in. and 24-in. I-beam rafters, 7-in. I-beam purlins, and built-up spandrels of various sections. The roof is flat except for slight drainage pitch, and alternates high and low in alternate bays in most of the area. The roof is poured-in-place gypsum with wire-mesh reinforcement.

The purlins, 7-in. I-beams at 15.3 lb., on 20 ft. spans, spaced about 7 ft. 6 in. on centers, rest on top of rafters

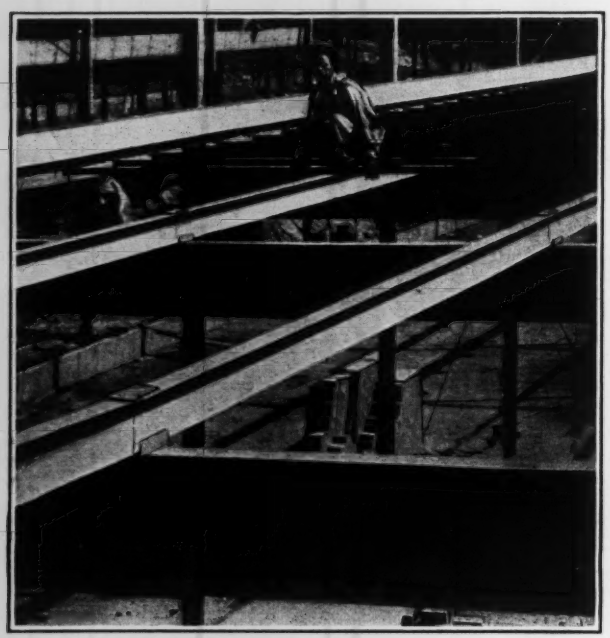


FIG. 2—PURLINS MADE CONTINUOUS BY WELDED PLATE ON TOP FLANGE AND BUTT WELD ON BOTTOM FLANGE

except where the rafters are high, as at outer walls. Except at ends of rows, the purlins are continuous, this condition having been produced by welding tension plates to their top flanges and by butt-welding between bottom flanges at the joints. Except for this continuity, 8-in. I's would have been required. The typical rafters, which are on 30 ft. span from column to column, are 18-in. I-beams 54.7 lb., and, in general, are slightly pitched for roof slope. They are connected to the columns by side angles, one at each end, and are not continuous because consecutive rafters are at different elevations.

Welding Procedure—To suit the contractor's convenience, it was arranged to do all welding in the field. All columns were milled and punched, the punching being for erection bolts only. Spandrel beams were punched for erection bolts, and also for assembling where composed of two or more members, and also for bolts to attach wood facias where required. Rafters and purlins were shipped from mill to jib without fabrication.

A typical rafter detail, with column connections and support for purlins on top flange, is shown in Fig. 3. Since there was no opportunity for continuity of rafters, there was no object in using a rafter-to-column connection having a high bending strength. On the other hand, the deflection of the rafter under full load would be likely to crack a weld joining the web of the rafter to the flange of the column. The natural choice therefore lay between a seat connection and a side-angle connection; the latter was selected because it afforded a high and a low erection bolt with a minimum of field labor. It should be noted that the welding is arranged to allow twisting of the connection angle, without distortion of the welds, when the rafter sags under load. The small channel seats for purlins, as well as the end connection angles, were welded to the rafters before erection. Wood templets and a steel tape were used by the foreman welder and his helper in locating the connection members before welding, C-clamps holding the small parts in place until welded. In spite of the different angles of pitch, and the different distances back to back of connection angles, no errors were made in locating the parts, the rafters all going accurately into place when erected. No erection bolts were provided for purlins, which were lowered into the channel receptacles without any fastening. All bolts used for shop assembly of spandrel beams and for field erection were left in place after welding, because they were not considered worth the cost of removal. All painting was done after erection.

Shop drawings were simpler and cheaper to prepare than for a corresponding riveted structure, because of the small number of holes in the fabricated members, and the complete absence of fabrication on three-fifths of the material. Field welding sketches, distinct from shop drawings, were prepared for use by the welders, who rarely had occasion to refer to the shop drawings.

Unit stresses for design of welds were as follows: $\frac{1}{4}$-in. fillet welds in longitudinal shear, 2,000 lb. per in.; $\frac{5}{16}$-in. fillets, 2,500 lb. per in.; butt welds in compression, same as rolled steel (18,000 lb. per sq.in.). On this job, butt welds in tension or shear, and fillet welds in transverse shear, were not used. Where there was eccentricity in connections, as in the single side angles supporting rafters, it was allowed for.

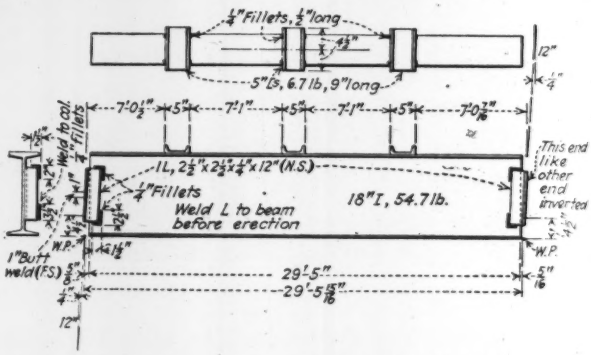


FIG. 3—TYPICAL RAFTER DETAIL SHOWING COLUMN AND PURLIN CONNECTION

The structure was built by the Jones & Laughlin Steel Corp., from plans by B. H. Prack, architect and engineer of Pittsburgh. G. H. Danforth, contracting engineer for Jones & Laughlin, was in charge of the operation. Minnotte Bros. Co., Pittsburgh, handled steel erection for the contractor. W. S. Rugg, vice-president in charge of engineering for the Westinghouse Electric & Manufacturing Co., exercised general supervision. Inspection of welding for the owner was by A. M. Candy, welding engineer of the Westinghouse Electric & Manufacturing Co. William Norberg was foreman of the welders. The writer acted for the contractor as consulting engineer. The welding equipment used on this job consisted of three portable Westinghouse motor-generator sets, 200-ampere single-operator type, with alternating-current motors.

FIFTH OF A SERIES OF ARTICLES:

Today in the Mississippi Flood Area

Engineering and Human Conditions in the Basins and Along the Levees as an Engineer Sees Them

By W. W. DeBerard
Associate Editor, Engineering News-Record

V—The Sugar Cane Industry and Atchafalaya Crevasses

IN A WAY the 1927 flood in Louisiana was a blessing in disguise to the sugar cane industry as a whole. The fields of cane were so infected with the mosaic disease that yields had dropped to bankrupt figures in 1926. Scientists have produced new tolerant varieties, but the planter had not been "sold" on them, for the ordinary reasons of inertia, lack of publicity and heavy expense for the new seed. The new varieties proved far more resistant to inundation, and an ocular demonstration of far-reaching value was exhibited when the yellow rotting Creole varieties were compared with the few fields of vigorous varieties even after immersion for 6 to 8 weeks.

Long before I got to New Orleans up-river cotton planters had told me that the sugar planters were in a bad way. They attributed the hard luck of their sugar producing friends to unwise extensions into sugarmill machinery. In consequence it seemed especially appropriate to look into the sugar situation more than casually.

In an interview of optimism with L. M. Pool, vice-president of the Marine Bank & Trust Co. about the general economic situation the question of the solvency of the sugar industry generally was broached. He indicated that for the past few years there had been a decided slump; that the cane area was limited; that the mosaic disease had about finished many of the planters; that the crop was "made" largely on the "gang" system of day labor with the laborer getting $1.25 to $1.50 per day, though there was a certain amount of share cropping and renting done; that the new varieties of cane were well established and promised to rejuvenate the industry; that much of the labor which had left during the flood was flocking back because it liked to "make sugar"; that credit conditions were healthy; that the big banks could amply care for the small ones in the country districts; that some of the country banks had money in Wall St.; that one small bank had only recently asked where surpluses might be placed; and that the various credits established had made credit easy enough, perhaps too much so. Mr. Pool checked previous information up the valley to the effect that the first of the year would show the greatest strain, since planters must then arrange for financing the 1928 crop. He was entirely optimistic about passing that period without undue difficulty. As to the sugar cane slump and bright future he referred me to Dr. A. H. Rosenfeld, consulting technologist for the American Sugar Cane League and the State Agricultural Credit Corporation, Inc.

Later I saw Dr. Rosenfeld. Nowhere have I ever been so impressed with the story of the remarkable assistance that research science can give to an industry as I have in listening to this sugar expert.

Dr. Rosenfeld is a Louisiana-trained scientist sent in 1910 to Argentine from the Audubon Park Sugar Experiment Station in New Orleans. The province of Tucuman suffered steadily declining yield due to degeneration caused by mosaic disease, the same scourge that has more recently ruined Louisiana's crop. Mosaic is a disease, the exact cause of which is not well known but it is akin, at least, to a filterable virus such as that which causes scarlet fever. The Tucuman plantations were 100 per cent infected, and the experimenters set out to find types of cane which through tolerance or immunity would replace the Creole canes, which had come from the same stock that have been used so long in Louisiana. Yields in Tucuman declined from 263,000 tons in 1914 to less than 45,000 tons in 1916 and 1917, conditions paralleling those of Louisiana when in 1925 and 1926 her fields yielded less than 7 tons per acre.

For the tests to locate resistant or tolerant canes 126 varieties were brought to Argentine from Louisiana, 76 from Brazil and 6 from Java, where similar experiments had long been carried out to combat Sereh, another dread disease of sugar cane. The Java canes were found particularly tolerant of mosaic. They are called locally P.O.J. varieties from the East Java Experiment Station, (Proefstation Oost Java, hence the initials) and the yield was found about three times that of the native varieties. In addition the juice contained more crystallizable sugar, there was greater resistance to mosaic and other diseases, as well as of insect ravages, it could stand lower temperatures and furnish more and better fuel bagasse. In Louisiana, with its Celotex industry, the increased bagasse content is important. In fact, this by-product use has been a decided factor in helping rehabilitate the sugar industry.

Now, as to Louisiana. In 1925 the condition of Tucuman in 1916 and 1917 was paralleled, with yellow fields of low yield. But already a few acres of the new canes with their vigorous growths were in existence. The 1926 hurricane centering over Houma, where much of the new stock had been planted, showed that it had remarkable resistance to physical punishment. The old stock was broken and battered, producing only 4 tons per acre to 14 tons of the new P.O.J. Seed supply was cut 40 per cent by the storm, but 23,500 acres were laid down this past year. Of this the flood immersed 5,000 acres, but not more than 1,500 acres were ruined. About 125,000 to 150,000 acres is the total normal acreage cultivated; the flood destroyed 33,000 acres.

The flood precipitated the financial question of money for seed. Sugar cane is not actually reproduced from seed but propagated by laying down in the fall a double line of canes in rows about 6 ft. apart and covering with earth. At each joint is an eye from which a new shoot sprouts. In the spring about 2 in. of the earth cover, put on 4 in. deep for frost protection, is scraped off. The first or "plant" crop is cut late the next fall. Two "stubble" crops during succeeding falls are usually cut,

and then the land is plowed up and some nitrogenous enriching crop like alfalfa, cow peas or soy beans grown for a year or two. Thus three crops in five years is about the average and the plantation owner rotates his fields, utilizing as much as 30 to 50 per cent of his crop (the old varieties) for seed. Much less seed is required with P.O.J., the eyes are closer together, and they are more sure of growing. Crops expected are 25 tons per acre the first year, 25 the second and 20 the third. Further crops may be made, but not if production falls below 12 tons.

From 21 eyes in three stalks brought to Louisiana in 1922 there has now been developed enough to plant the total normal acreage this last fall and leave 250,000 tons for grinding.

Returning now to the financing, many of the planters last fall saw their salvation in P.O.J. but had no means to purchase seed. Business interests, bankers, railroads and the by-products people formed the State Agricultural Credit Corporation, Inc., with a capital of $325,000, which was deposited with the Federal Intermediate Credit Bank at New Orleans. This capital would permit borrowing some three or four times the amount from the Intermediate Credit Bank. Another $250,000 was required for financing the 1927 planting. Money was loaned only to planters who would plant P.O.J. stock. Last year the corporation financed one-quarter of the crop. Dr. Rosenfeld is positive that many loans will be repaid next year and that eventually the original investment will be returned to the founders of the corporation. Thus there will be returned to Louisiana a purchasing power of 40 to 50 million dollars annually through the practical adaptation of science to industry aided and accelerated by the experience of the 1927 flood.

What sugar land in general is worth, and what that inundated is worth, cannot now be easily estimated, for few plantation owners are willing to set values when a new era of twice the tonnage and 20 per cent greater sweetness appears, one might say, even nearer than the horizon.

Some yields of various plantations, given in the accompanying table, indicate that first and second stubble crops (second and third year) are as good as the plant or first year crop. A ton of the P.O.J. cane produces from 8 to 10 per cent of sugar, or on the basis of the table from 2 to 3 tons per acre.

A large local planter estimates that the new varieties are now yielding an average of 20 tons of cane or $1\frac{3}{4}$ tons of sugar which will be increased by 20 per cent with normal planting. Planting of new varieties has been very thin intentionally on account of the scarcity of seed. Good sugar land with some improvements but no mill and no crop is valued at $70. There has not been much increase due to new varieties but the market has been made more firm and loans extended thereby. Dr. Rosenfeld states that of late years land which might have been picked up at $30 to $35 has now come back to a value of $75 to $100, the price average before the ravages of mosaic. Based on earning power of 2 to 3 tons of sugar three out of five years such land should bring upward of $150 per acre but no one sees that price ahead at present.

In the "Sugar Bowl" country in the latitude south of Baton Rouge there is a restricted high-value district, but there are likely to be many acres of sub-marginal land in the vicinity added to the 135,000 acres Dr. Rosenfeld feels is worth cultivating for sugar.

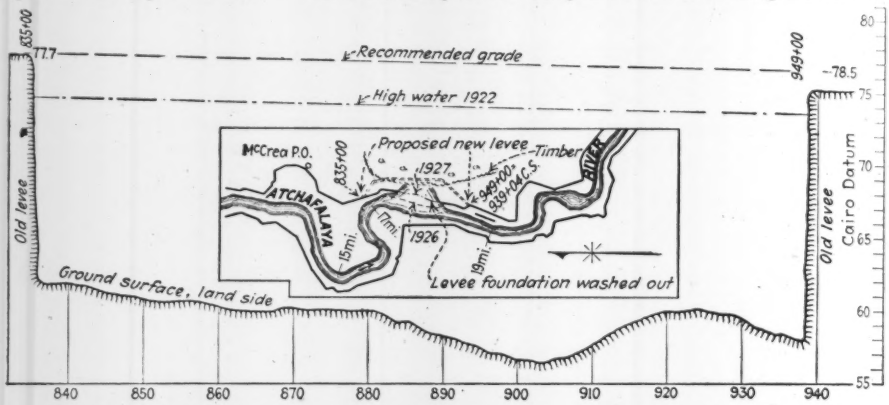


FIG. 1—CROSS-SECTION OF McCREA CREVASSE AND PLAN OF LOOP LEVEE

YIELDS OF P.O.J. CANE

Date	Plantation	Variety	Age*	Tons of Cane per Acre
10- 4-27	Acadia	P. O. J. 234	Plant	33
	Enterprise	P. O. J. 213	Plant	30
	Laurel Grove	P. O. J. 213	Plant	26
		P. O. J. 36	Plant	28.8
10-26-27	Ardoyne	P. O. J. 213	Plant	35
	Ardoyne	P. O. J. 213	Plant	34.12
10- 5-27	Southdown	P. O. J. 213	First Stubble	27.54
	Texas, White Castle	P. O. J. 234	Plant	25
	Wilbert's Myrtle Grove	P. O. J. 234	Plant	25
9-15-27	Raceland	P. O. J. 213	Plant	26.6
10- 6-27	Edna	P. O. J. 213	Plant	25
	Evergreen	P. O. J. 36	Plant	27.5
10- 7-27	Southdown	P. O. J. 36	First Stubble	37.51
10- 5-27	Southdown	P. O. J. 213	First Stubble	32.90
10- 7-27	Supple's Catherine	P. O. J. 213	Plant	28
	Supple's Catherine	P. O. J. 36	Plant	26
11- 1-27	Expt. Sta. Baton Rouge	P. O. J. 213	Plant	42.6
10-26-27	Ardoyne	P. O. J. 36	Plant	27.9
11- 2-27	Southdown	P. O. J. 213	Second Stubble	30.75

*"Plant" means crop from first year's planting and "First Stubble" from second year's growth.

Like all agricultural propositions there is always a "catch" somewhere. John F. Coleman says sugar cane breeds degenerate after about 20 to 25 years, this present occurrence being the third in his experience.

Two vital points come from this discussion: (1) What is the value of the sugar area that will be saved or lost by the proposed levees and floodways along the Atchafalaya and (2) What is to be the price of land that is now or will be planted to sugar cane that will lie within the floodway and have to be settled for either by easement or purchase?

It may not be amiss here to add that 20,000 acres of sugar land in the vicinity of Houma were saved by new low levees or topping old ones as a result of the warnings sent out by the veteran New Orleans weather forecaster, Dr. I. M. Cline. Much of this acreage was P.O.J. seed stock; thus science again assisted in saving the sugar industry. In preparing these predictions Dr. Cline made observations on the rate of advance of the flood waters. He came to a general average of 7 miles per day in the flat Louisiana delta country.

Melville and the Atchafalaya Crevasses—Since some of the water which escaped from the Atchafalaya levee breaks at Melville and McCrea, La., caused the sugar field flooding, a few observations made of these two

crevasses on Dec. 1 are included in this article. McCrea first, for it is up-river from Melville and was visited first after a drive from Baton Rouge over the ferry through country almost continuously flooded, not once but twice in 1927.

The break occurred at McCrea May 24 in the east side levee, and was due not to a failing levee but to undermining of its foundation. Inspection of maps showing the bank line in 1912 and again in 1922 (this was a state levee, though its repair has been undertaken by the Mississippi River Commission as an emergency measure) indicates that the batture or bank on the river side of the levee had been eaten rapidly toward the levee, and that by 1927 there was not much batture left. Lack of funds had precluded repairs in the way of a loop. Not a large blue hole was formed—perhaps because the site was an old cypress brake studded with stumps and "knees" and also because a certain amount of backwater head was built up due to the short distance (less than a mile) to a heavily wooded swamp. This same absence of heavy cutting was noted at Cabin Teele on the main river, where the break occurred in wooded country. As the river reaches the Gulf in half the distance it has twice the slope of the Mississippi, and in consequence has a much more rapid cutting capacity. It is working in virgin territory, however, as within the memory of the oldest inhabitant it once was only a chute across which men walked on logs.

Whether the policy of the M.R.C. to set back levees in the main river when cutting gets within 5 years of the levee would have sufficient factor of safety on the Atchafalaya is a question. Certainly a setback would have been made before it got within 1 or 2 years of the levee, had funds been available. The M.R.C. officials are watching all caving banks with appraising eyes. I visited one south of McCrea that is probably within the five-year limit, and was surprised to find caving extending back into the bank 100 to 200 ft. by general slumping and settling at least five feet vertically.

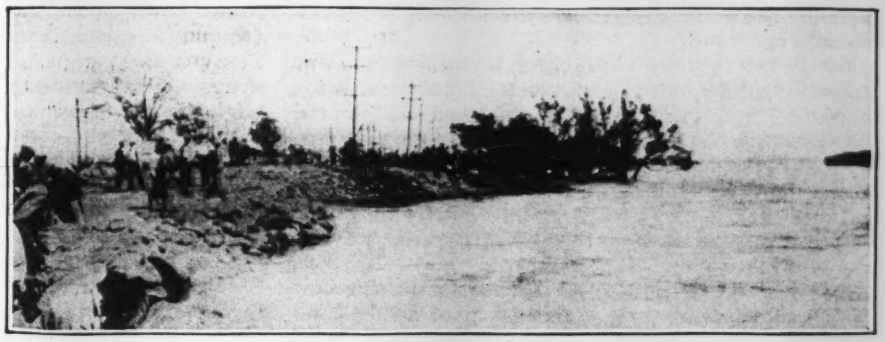
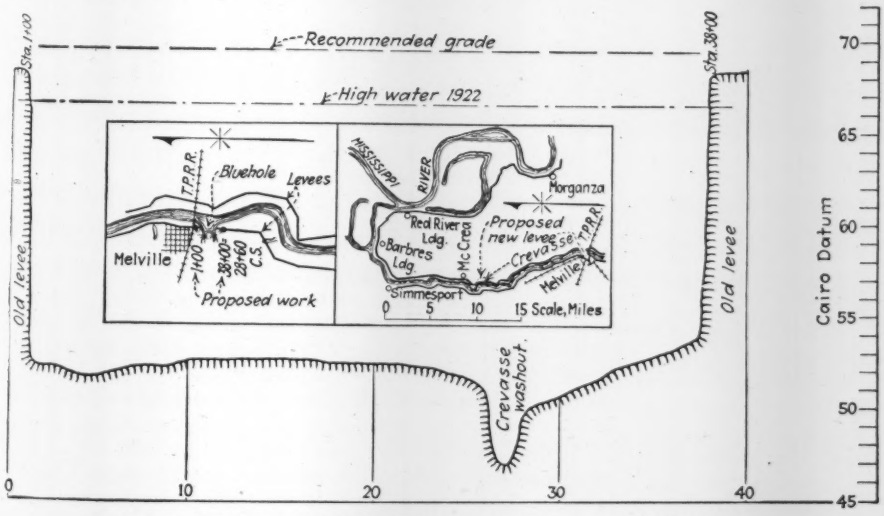


FIG. 3—EMERGENCY WORK TO HOLD A LEVEE

The original crevasse carried away 2,000 ft. of levee, but the loop levee to repair it is two miles long in order to enclose the blue hole and set back the alignment to a safe distance, assumed at 20 years, away from the bank-eating river. The job calls for the movement of 600,000 cu.yd., about 5,000 cu.yd. per station for most of the alignment. A low bid of 31c. per yard was obtained, which was so much more than the 16c. estimated that all bids were rejected until the low bidder revised his bid to 24c. for the upper three-quarters. It is not the policy of the Fourth District of M.R.C. to let contracts when the low bid is much beyond 25 to 30 per cent over the estimate, but in this case the policy was stretched to 50 per cent. The contractor put on two dragline machines and the M.R.C. added one of their smallest 3-yd. draglines, averaging 50,000 yd. moved per month at a 9c. field cost, which with 3 to 5c. administration cost will still be measurably below the estimate.

The state section, which is considerably thinner and with much steeper borrowpit slopes than M.R.C. standard, materially reduced the yardage and costs. For the method of handling (with draglines), 20 per cent shrinkage was allowed. No particular difference in section was made for the various materials encountered. A center trench of about 10 to 15 ft. wide was excavated as a cutoff in which all stumps were removed, but they were not removed over the remainder of the levee base. Land values are $30 per acre within the cleared area paralleling the river in a strip from ½ to 1½ miles wide, back to the low swamp land valued at from $3 to $10 per acre.



NO. 2—MELVILLE CREVASSE AND NEW LEVEE AROUND IT

Melville—Never, aside from the pathetic scenes of Dayton after the 1913 flood, have I seen more evidence of water devastation. Fourteen years ago I reached Dayton within 36 hours after the waters left town, but this was more than six months after the levee blew out. No one saw the blowout, the time was early morning, when the 1,000 people of the town were just getting up, and they had only an hour to rush to the levee or the railroad embankment which runs at right angles to the levees south of most of the town. Restriction of flow through subway entrances under the railroad gave the

people the needed time to get out. Back levees eventually were all overtopped.

So close was the town to the crevasse that fine sand was washed in and deposited in the streets, houses and yards from 1 to 7 ft. deep. Removal of this sand has been the most expensive undertaking to rehabilitate the town. The Red Cross donated $125,000 to Melville for private use and the State Highway Department hauled away the sand deposited in the streets. Many owners of vacant lots are using the sand as filling and terracing; a few have raised their houses to the higher levels.

Right here let me interpolate that it is surprising how few houses in all of these inundated areas are built on elevated foundations. Rises in land are usually occupied and so are a few mounds of historic origin, but even in the best part of New Orleans less than 50 per cent, I would estimate roughly, are elevated more than 3 to 4 ft. above ground level.

Melville still is digging out. The brick schoolhouse has new furniture in the flooded first floor. Most of the stores have new stock. An air of briskness pervades the main street. Half a dozen negroes were loading sand from a vacant lot and from under a store adjacent on the main street. Red Cross workers were building a few new houses of the contractor's shack type and underpinning many more. Brown refugee tents were still in evidence, though not many. As in Arkansas City, house-moving trucks with eight low wide-tired wheels were in use. A drive of five miles to the west along the railroad showed where the waste sand from the town went; then beyond were farms with sand ridges and tongues stretched out behind any kind of velocity-checking obstruction. The sand is extremely fine, almost like quicksand. People accustomed to floods usually follow the water as it recedes to floor level, scrubbing and sweeping the muck out of their houses, but the Melville sand was too thick for anything but shovels.

Typical of the economics of the whole flood rehabilitation problem was a remark of one of the engineers who accompanied me through Melville. "Is it worth while for sentimental or any other reason to spend $500 to excavate a $300 house? Would it not be economy to burn, tear down or abandon the thousands of structures which at best are questionable as habitations?"

The crevasse at Melville is being looped by a levee containing 190,000 cu.yd., by a contractor who bid 23 cents. Early progress was good, but an idle M.R.C. dragline was being unloaded off a barge Dec. 1, to help the contractor complete the work by Jan. 1, two weeks beyond the contract date. The blue hole was small, and as at McCrea the foundation was full of stumps. No effort was made to remove them aside from a central cut-off trench. At first the railroad, which lost a pier at the west end of a swing draw-bridge, figured on moving the crossing upstream, but recent shipments of a large amount of stone ballast for filling around the existing piers indicate that it may have other plans.

The fate of the people in this area hangs on future action of the U. S. Government. So far they are hanging on, hoping for better protection, sale of property or reimbursement for easements for a floodway, or for some other exterior movement. One woman who had a vacant lot considerably elevated by the sand stated that her holdings were more valuable than before the flood. It would hardly seem reasonable to find prospective purchasers, but people cling to home localities with an unbelievable tenacity. Where there are people there is business, and business brings competition and more people. Just so all over the inundated areas traveled, at least 1,500 miles, were continued stories of people, whites as well as blacks, struggling back to their former locations from which they originally fled "never to return."

While these two crevasses on the Atchafalaya, the one to the east at McCrea and that to the west at Melville, added to the local floods, they accentuated the overflows of the lands downstream and back from the river. Young as it is, the river has overflowed enough to build up the area immediately adjacent, higher than the swamps 1 to 2 miles away. At the time the levee blew out Melville itself was already being flooded from the Bayou des Glaises breaks. The levees would have been overtopped due to the abnormal filling up of the Tensas basin feeding down the regular channel.

The report of the Chief of Engineers calls for strengthening the levees to afford protection 14 out of 15 years, but it also makes of the whole valley a floodway with a "fuse plug" system of levees at its head. Morgan City, Melville and Simmesport are to be inclosed by protection levees. This is the space best available hydraulically for the surplus waters to reach the Gulf, says the report.

The Atchafalaya never should have been leveed. It is 80 per cent swamp land now and the plan is to protect the developed lands to the same extent they now are protected, i.e., 14 out of 15 years. Will the sands of Melville be forgotten, the town again be prosperous and the back levees high enough when the next flood courses down the floodway 15 years hence?

The work of repairing these crevasses under state control as well as that of more than 50 other jobs under way by the M.R.C. in the Fourth District are under the charge of Major W. H. Holcombe, Corps of Engineers, U. S. Army. His military assistants are Capt. Thomas D. Stamps and First Lieutenant John M. Harman and his principal civilian assistant, George D. Waddill, associate engineer, who is in charge of lower river revetments. D. L. White is assistant engineer in charge of upper river revetments and F. C. Carey, assistant engineer in charge of levees. The major portion of the levee work is being carried out by some 25 contractors. On Nov. 1, 45 jobs were under contract and seven additional levees were being built by government machines. Revetment work is done practically all by Government forces.

Holland Tunnel Driving Records

A review of the data concerning the Holland vehicular tunnel at New York, published in this journal reveals the fact that no record has been made of the accuracy with which the shields met in driving the twin tubes under the Hudson River. Coming at the time of the death of Clifford M. Holland, the event did not receive the attention that otherwise would have been given to it. The headings of the north tube met Oct. 29, 1924, and the headings of the south tube met Dec. 7, 1924. Check of the alignment and grade gave the following results:

	North Tunnel	South Tunnel
Line	0.30 ft.	0.29 ft.
Level	0.02 ft.	0.03 ft.
Distance	0.54 ft.	0.73 ft.

The north tube headings met 585 ft. west of the Manhattan pier-head line and 2,605 ft. east of the New Jersey pierhead line. The south tube headings met 660 ft. and 2,540 ft. respectively, from the pierhead lines.

Central Power and Heating Plant For University of Iowa

Addition to Old Dam Provides Distribution Pipe Tunnel Across River—Turbines Have Separate Foundations

By B. P. Fleming
Head of the Department of Mechanical Engineering, University of Iowa, and Consulting Engineer, Iowa City

IN PREPARING plans for a large group of medical buildings at the University of Iowa, careful consideration was given to the necessary additional heating, lighting and power facilities. The writer was engaged to study the problem and report not only upon the requirements of this proposed group of buildings but upon a comprehensive scheme of heat and power development for the entire institution.

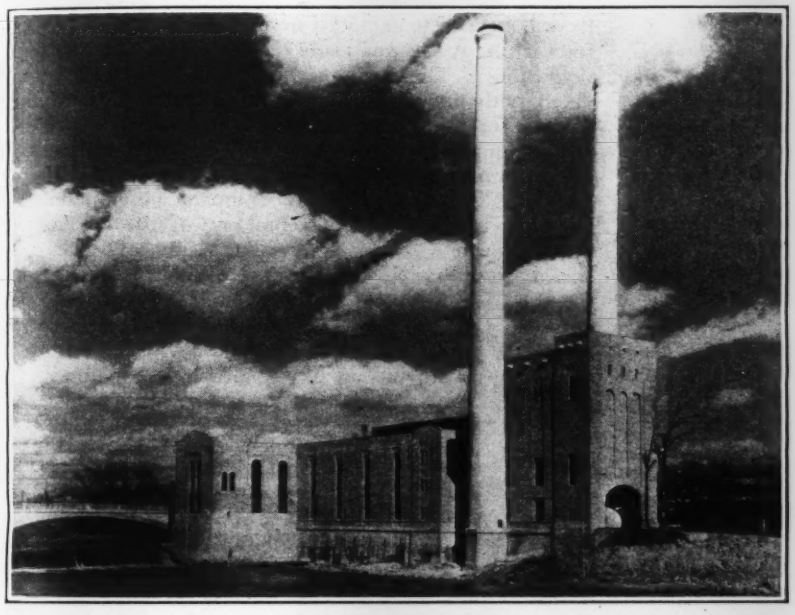


FIG. 1—NEW POWER STATION: UNIVERSITY OF IOWA
Power dam under bridge carries stem pipes in tunnel.

The Iowa River, about 350 ft. wide, subject to flashy floods of variable volume, flows southward through the campus. The university buildings chiefly occupy the bluffs for about ¼ mile back on either side, with the athletic field and open campus in the ¼-mile flood plain between, making a total width of built-up area of about ¾ mile. At the south (lower) side of the campus, the university has a low-head power dam with the hydro-electric plant at the east end. The university has been served by four heating plants, one of which was also a power plant, with a partial system of distributing tunnels.

The new general plan consists of a central power and heating station at the east end of the dam, with heat distribution tunnels extending to the various buildings on either side of the river. The river furnishes abundant water for condensation, and coal may be delivered on a railroad spur. This central station, Fig. 1, will comprise a boiler plant built in units of four boilers each, all served by coal- and ash-handling facilities. One unit has been installed. The building is so located that the hydro-electric plant is housed in one corner, with space left for a second hydro-electric unit. A distribution tunnel was extended across the river by utilizing the existing power dam as the upstream cofferdam for an addition built against the downstream face, with the tunnel formed in this addition, as shown by Figs. 2 and 3. In this way the old dam, which was beginning to show signs of deterioration, was strengthened and repaired, and a tunnel was secured for a safe and dry conduit for steam mains.

The substructure of the heating plant was planned to be founded on rock, but the soundings were unreliable, since upon uncovering the site a fault was disclosed which necessitated the use of piling under the eastern half of the structure and added materially to the construction cost. In spite of this foundation partly on solid rock and partly on piling, no settlement cracks have appeared in the completed structure. The turbine foundations were carried down independently of the building to their own footings. The coal- and ash-handling unit, which is separate from the boiler room, is of reinforced concrete, with exterior brick facing. It comprises two 250-ton elevated coal bins and a 50-ton ash bin. The coal bins are not for storage primarily, but provide a bunker from which coal may be distributed by gravity to the boiler furnaces by an overhead motor-driven larry. The new concrete chimney is 9½ ft. in internal diameter at the top and 210 ft. high above the boiler room floor.

The main high-pressure steam header is connected to the tunnel lines through reducing valves and by-pases. A large low-pressure 20-lb. line, not yet installed, will convey bleeder steam from the main turbines and exhaust steam from turbine-driven auxiliaries to the low-pressure heating system on the east side campus. On the west side, high-pressure distribution is planned, with reducing valves at the buildings. The return water from heating systems on both sides of river flows to tanks in the low-level pump room by gravity, assisted by rotary vacuum pumps with automatic control.

Beneath the boiler room is a 250,000-gal. reservoir for water service for the institution. The rear end of

FIG. 2—PIPE TUNNEL IN CONCRETE DAM

the west row of boilers is supported by the roof of this reservoir, and its west wall is the west foundation wall of the boiler room. In flood time, when the lower floor may be 10 to 12 ft. below river level, drainage from the plant will be taken care of by an automatic sewage ejector in the base of the west chimney. The electrical generating

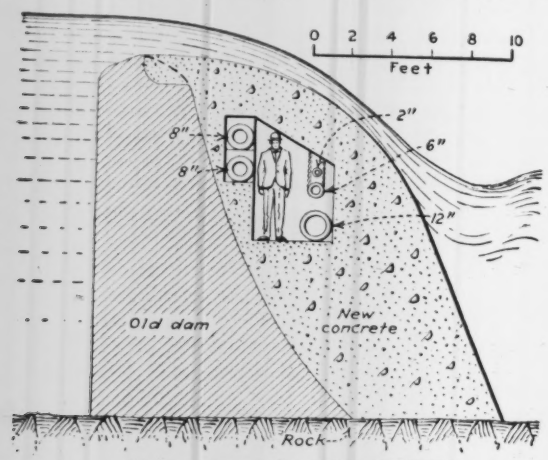


FIG. 3—DAM AND PIPE TUNNEL

equipment consists of two 1,250-kva. steam turbo-generators for two-phase 2,400-volt 60-cycle current.

The development of this entire project, including preliminary studies, detailed design and construction, has been in charge of the writer. The architectural design is by Proudfoot, Rawson & Souers, Des Moines, Iowa. A. A. Alexander, Iowa City, was contractor for the main building unit and distribution tunnels; Priester Brothers, Davenport, Iowa, were contractors for the river crossing and for the second boiler-house unit now under construction. The Heine Chimney Co. built the two reinforced-concrete chimneys.

New Australian Interstate Bridge Opened

The new bridge over the Murray River at Mildura which links the state of Victoria with a flourishing agricultural section of New South Wales was opened recently in Australia by the British Secretary of State for the Dominions, reports Assistant Trade Commissioner Chas. F. Baldwin, Sydney, to the Department of Commerce. The bridge is one of four which have been built across the Murray in accordance with the terms of the Border Railways Agreement, which provides for the construction of five bridges. Its completion was characterized as one more link in the chain of great engineering works being projected in that section of Australia. Not only does the new bridge connect the Victoria and New South Wales banks of the Murray but it promises to become a magnet attracting returns from lands which hitherto have not been developed to the extent of their potentialities. It links Victoria with millions of acres of rich arable land in the neighboring state, in which the quality of the soil is declared by experts to be equal, and often superior, to that of the fertile Mildura district. The cost of the recently completed bridge was £100,000 which is to be shared proportionately by the two states. Its main span over the river is about 800 ft. in length, but with raised approaches specially constructed to withstand floods, its total length is more than a mile and a quarter.

Steel Foundation for River Tower of Transmission Line

Tower Rests on Trussed Frame Supported by Steel H-Beam Piles Driven Through Sides of Frame

By Paul L. Mercer
Assistant Engineer, Mississippi River Power Company, Keokuk, Iowa

An ALL-STEEL type of river foundation recently developed for use in the electric transmission line crossing of the Mississippi River at Fort Madison, Iowa, and shown by the view, Fig. 1, is thought to be of interest to engineers in general, not only because of the advantages that led to its adoption in this particular installation but also because of the possibilities it may suggest for other similar applications. The departure from the concrete and steel designs more commonly used for such locations was made largely because of cost considerations. The steel pier cost only $7,500, as compared with an estimated cost of practically twice this amount for the nearest competitor in concrete.

The building of the new and removal of the old bridge across the Mississippi River by the Atchison, Topeka & Santa Fe Railway Company necessitated the relocation and consequent rebuilding of the Mississippi River Power Company's river crossing of a double-circuit transmission line from Keokuk to Burlington, designed for future operation at 66,000 volts. The old crossing, operating at 11,000 volts, rested on wooden structures on the old Santa Fe bridge, with a steel tower on the upstream nosing of the draw rest high enough to provide proper clearances for the cables spanning the

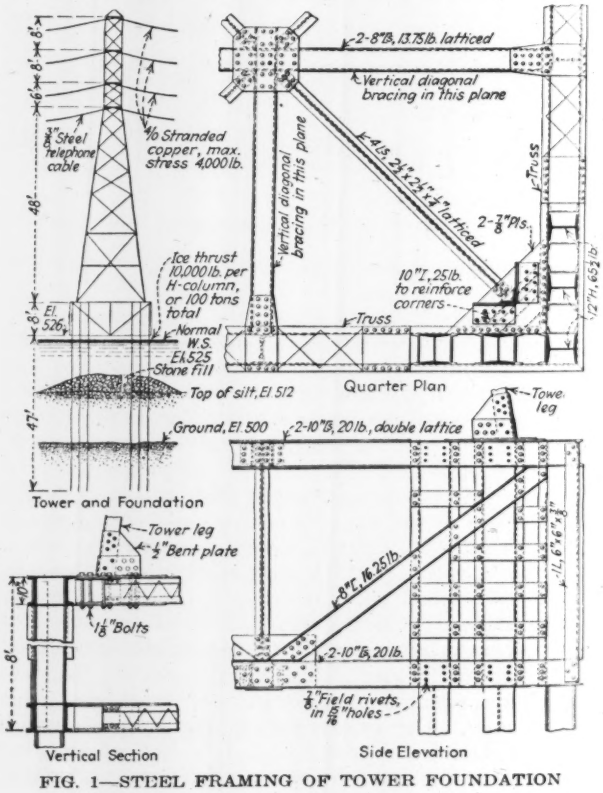


FIG. 1—STEEL FRAMING OF TOWER FOUNDATION

navigable channel. With the building of the new bridge the same method of support on the bridge and a tower on the draw-rest nosing was followed, but with all structures built of steel for permanence and to match the substantial and impressive appearance of the new bridge. However, in addition to these structures four towers had to be located in the open river, supported on foundations entirely independent from the Santa Fe bridge.

These four piers were in water 5 to 13 ft. deep but where river stages vary only slightly because of the backwater from the Keokuk dam. As the tower loads themselves were not especially severe, ice became the greatest factor affecting the design. Ice often freezes to a thickness of 20 in. in this section of the river, and pressures up to 4 tons per lineal foot of ice are known to have been developed by the expansion of the ice fields with temperature changes.

Three of the piers supporting the transmission towers in the shallower water were cared for by steel grillages resting on wood piles and buried in islands of sand built by the hydraulic fill method. This plan, however, seemed unsuited for the fourth foundation because of the depth of water, 13 ft., and because of the danger of scour. After carefully considering a great many possible designs, the all-steel pier was finally adopted.

The structure consists of a box-like steel-trussed frame through which twenty 12-in. Bethlehem H-column piles 60 ft. long were driven practically to refusal through silt, sand and hard clay. The trusses, which sit clear of the water, form the bracing for the piles and makes the foundation a rigid unit. The H-columns are designed to take the weight of the structure, the maximum uplifts and reactions of the transmission tower, and the heavy ice thrusts which may occur during the winter seasons. A total ice thrust of 100 tons in any direction was provided for, at maximum stresses of 22,000 lb. per sq.in. in the steel. Fig. 1 shows details of the steelwork.

In construction, all material and equipment had to be handled on barges. This fact made steel the most economical material to use because it provided the required strength with a minimum of bulk and because it required no cofferdam, cribs or underwater operations. It is believed that the combination of heavy steel sections, asphalted and submerged, has eliminated any cause for apprehension in the matter of corrosion of steel exposed to water.

The steel trusses were set above the water to keep them above the ice and to simplify their erection and the riveting of the piles to the trusses. In erecting the foundation the steel trusses were first built up on timber falsework and securely anchored in the location desired by means of temporary wood piles. The trusses were then used as guides for driving the steel piles with swinging leads. The twenty piles were all first dropped through their respective slots in the trusses and rested on the river bottom so that the structure might have as much support as possible against being disturbed by the driving of any of the piles. Fortunately no obstructions were struck in the driving and an approximate penetration of about 35 ft. was reached by each pile. After driving, the tops were cut off flush with the trusses, rivet holes burned and reamed in the piles, and the structure riveted together. All exposed steel was then given two coats of asphaltic paint and the falsework was removed, leaving the foundation ready for the tower.

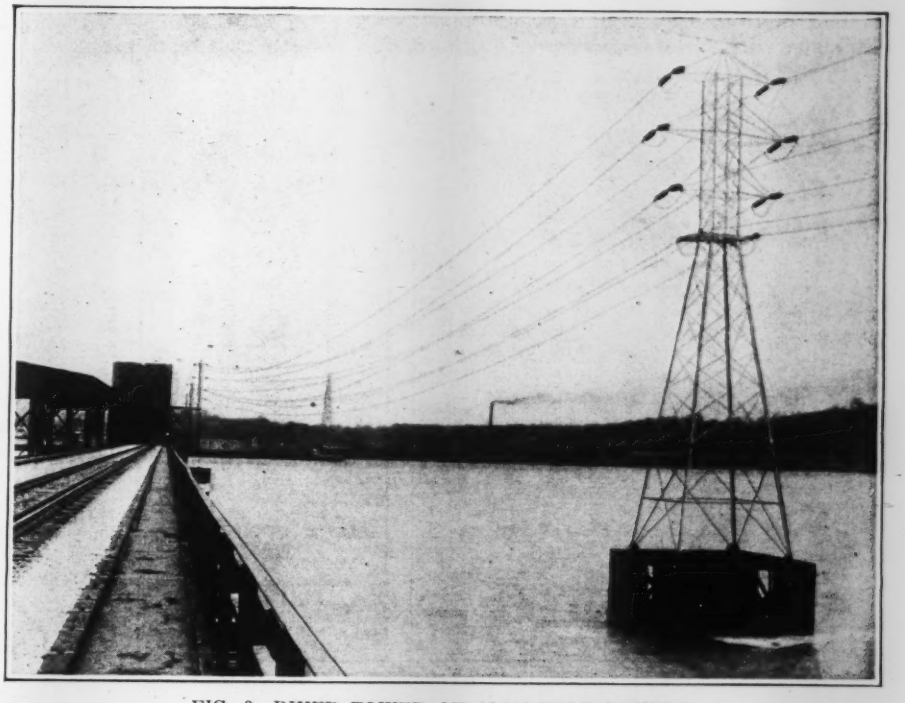


FIG. 2—RIVER TOWER OF 66,000-VOLT DOUBLE TRANSMISSION LINE AT FORT MADISON

Later a pancake-like layer of rock 6 ft. thick is to be placed around the steel piles to give greater rigidity at the river bottom, which consists of a finely divided silt deposit overlying the alternate layers of coarse sand and hard clay found in the lower depths.

In over-all dimensions the foundation is 20 ft. square and the trusses 8 ft. in height. The top and bottom chords of the trusses consist of two 10 in.-20 lb. channels double latticed and spaced 12 in. back to back. This spacing was just sufficient to allow the H-sections to drop through comfortably.

The foundation was designed by the writer under the direction of Albion Davis, chief engineer of the Mississippi River Power Company. Steel fabrication was by the Kansas City Structural Steel Company and erection by the Union Bridge & Construction Company, M. C. Taylor was superintendent of erection. The last-named company had the contract for building the bridge piers and abutments of the new bridge and for the removal of the old bridge. It therefore was well equipped for economically handling the erection of the transmission tower foundations.

Repair of Hurricane Damage to Two Miami Buildings

Condition of Meyer-Kiser and Realty Board Buildings—Value of Ordinary Wind Connections—Upper Part of Meyer-Kiser Building Removed—Realty Board Building Stiffened by Extra Bracing

By E. A. Stuhrman
Structural Engineer, Miami, Fla.

RECONSTRUCTION of two high steel-frame office buildings in Miami, Fla., that had been damaged by the great hurricane of Sept. 18, 1926, was carried out during the past year. The Meyer-Kiser Building, which had been greatly distorted, was partly taken down; the upper ten stories were removed, so that the building is now only seven stories high. The Realty Board Building, which was damaged mainly by the partial destruction of walls and partitions, was strengthened by additional bracing of the steel frame. The writer was the engineer in charge of the reconstruction of both buildings.

A general report of the action of the hurricane and of the condition of the two buildings in question was given in *Engineering News-Record* at the time (Sept. 30, p. 554; Oct. 7, 1926, p. 586, and Oct. 14, 1926, p. 624). More detailed examination of the buildings subsequently, however, gave much fuller knowledge of their condition and their resistance to wind action, as brought out in the present article.

Condition of Meyer-Kiser Building—Of the two buildings, the Meyer-Kiser suffered by far the more severe damage (see Fig. 2, showing the relative locations and the distortions of the two structures). As described in the previous articles, above referred to, it was bent about 2 ft. out of plumb, the distortion of the south or front face occurring in the seven stories between the third and tenth floors, while the parts above and below this remained practically plumb.

In comparison, the Realty Board Building was found to have only very slight distortion. Enlarged diagrams of column profiles and a top plan of this structure are shown in Fig. 4. The maximum displacement of the top tier with respect to the base was $3\frac{7}{8}$ in. northwestward, as determined by careful surveys. A considerable twist in the steel frame is evident. While some of this may have been due to erection inaccuracies, the amount is far in excess of the limits specified by the American Insti-

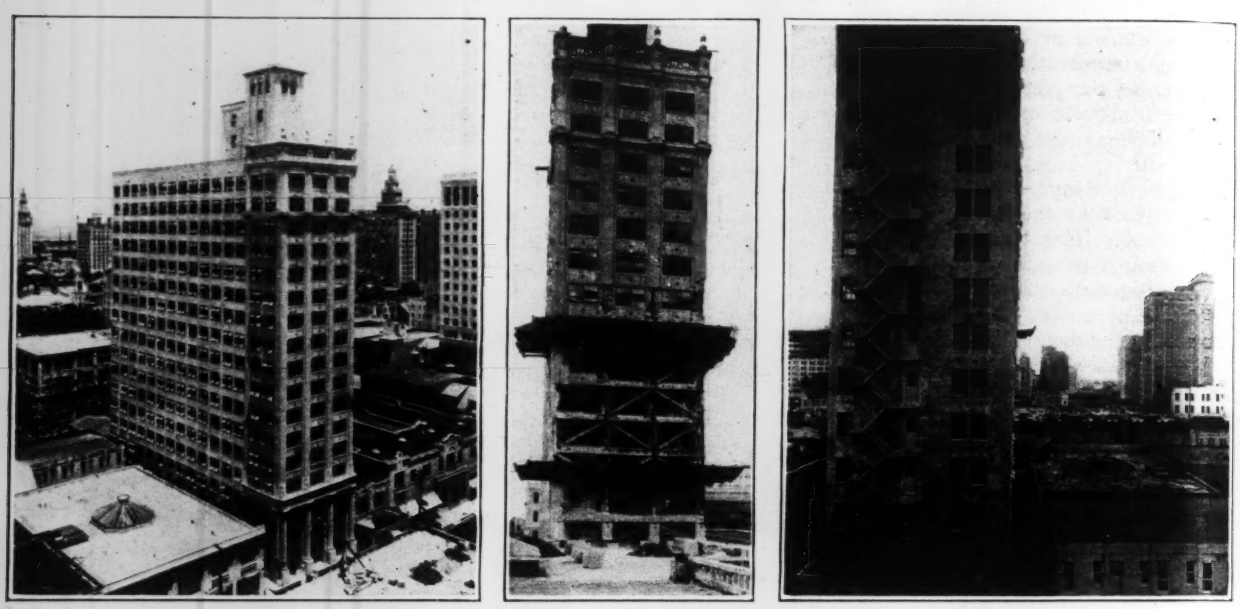


FIG. 1—MEYER-KISER BUILDING, MIAMI, WRECKED BY THE 1926 HURRICANE
Left: Building before the hurricane. Center: Front of building at start of demolition work, after the hurricane. Braces and staging placed for demolition work. Right: Rear view, showing twist of structure.

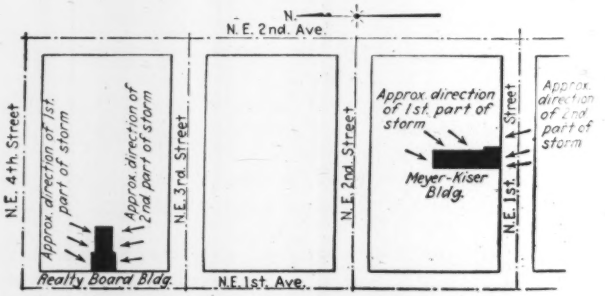

N.
N.E. 2nd. Ave.
N.E. 4th. Street
Approx. direction of 1st. part of storm
Approx. direction of 2nd part of storm
N.E. 3rd. Street
N.E. 2nd. Street
Approx. direction of 1st. part of storm
Meyer-Kiser Bldg.
N.E. 1st. Street
Approx. direction of 2nd. part of storm
Realty Board Bldg.
N.E. 1st. Ave.

FIG. 2—LOCATION AND DISTORTION OF MEYER-KISER AND REALTY BOARD BUILDINGS, MIAMI
Approximate direction of the wind during the first and second part of the storm indicated by arrows.

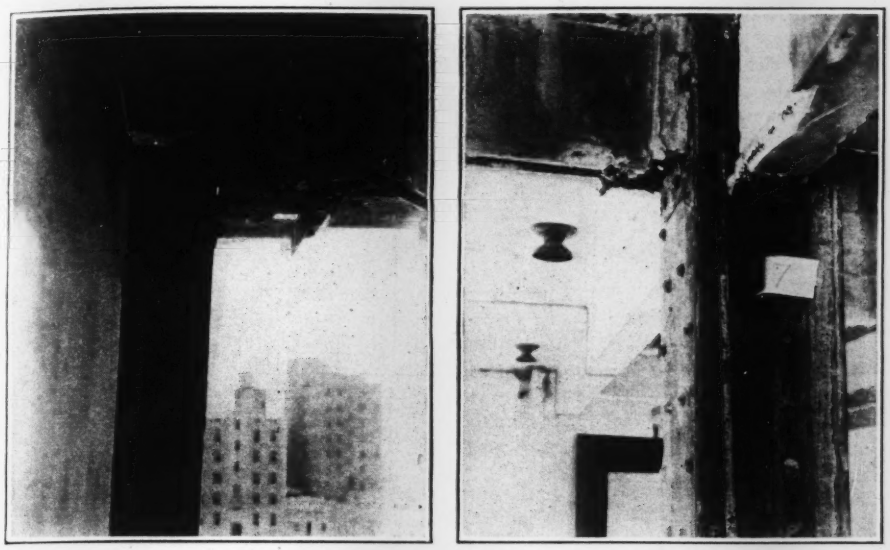


FIG. 3—FRONT-WALL COLUMN CONNECTIONS IN MEYER-KISER BUILDING
In the badly distorted part of the building the angles connecting columns and windbracing girders were bent or cracked. A cracked angle is shown at the right.

tute of Steel Construction. In the case of the Meyer-Kiser Building there is, of course, no doubt that the distortion was directly due to the hurricane.

In the front line of columns (Fig. 3) many angle connections were broken, and others were bent and partly pulled away from the columns. The columns were permanently bent between the third and tenth floors, the bending occurring above and below each girder connection, as brought out by the view Fig. 7. From the third bay to the north, however, the columns had no permanent set but were curved up in the form of a reversed curve from the ground up to the tenth floor.

As the upper stories of the building were taken down, the frame sprung back about 3½ in.; had it not been for the permanent set in the front columns it would have sprung back still more, I believe. The elastic spring of the frame manifested itself in a remarkable way by tremendous pressure on the timber diagonal bracing which was placed in the panels of the front wall during the demolition work as a safeguard. As the wrecking proceeded the bracing was not removed quickly enough, with the result that the 12x12-in. diagonal timbers in compression under the elastic spring-back pressure of the frame were bowed out of line about 6 in., and only with great difficulty could they be removed before failure.

The floor system in this building was of tile and concrete, but the spandrel beams were not incased in concrete. These floors, in the zone of distortion of the building, failed at each column due to torsional action. As the Realty Board Building, which had similar floors but with concrete incasement of the spandrel beams, showed no signs of failure in the floors, the writer concludes that all windbraced buildings should have their spandrel beams incased in concrete for the sake of the additional rigidity given by this incasement.

In both buildings it was evident that the floors acted as horizontal beams or cantilevers which transmitted the horizontal wind shear from one bent to another.

Reconditioning the Meyer-Kiser Building in its new and final height of seven stories was a relatively simple operation. The steel frame was amply strong for loads and lateral stress in this reduced height even in its distorted condition, and as it did not encroach on the property limits it was not disturbed. The columns were incased in reinforced concrete, and concrete spandrels were built out to the property line, so that, while the frame remains out of plumb, the concrete and masonry are true to line.

Realty Board Building—Interesting problems were presented by the fifteen-story Realty Board Building in the matter of determining whether it required strengthening and how the reinforcement could best by provided. The building is 45 ft. wide at the front (west face), 34 ft. at the rear, and 94 ft. 4 in. long east to west. Its total height from ground to roof level, excluding pent houses, is 165 ft. 9 in., which makes the ratio of height to width 5 to 1 at the east face and 3¼ to 1 at the west

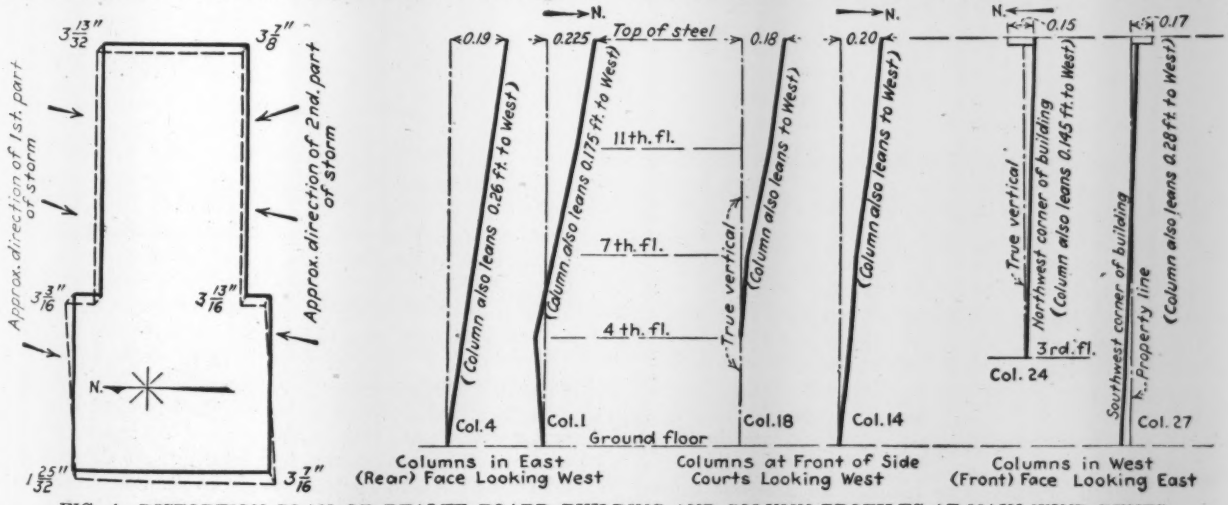


FIG. 4—DISTORTION PLAN OF REALTY BOARD BUILDING AND COLUMN PROFILES AT MAIN WIND BENTS

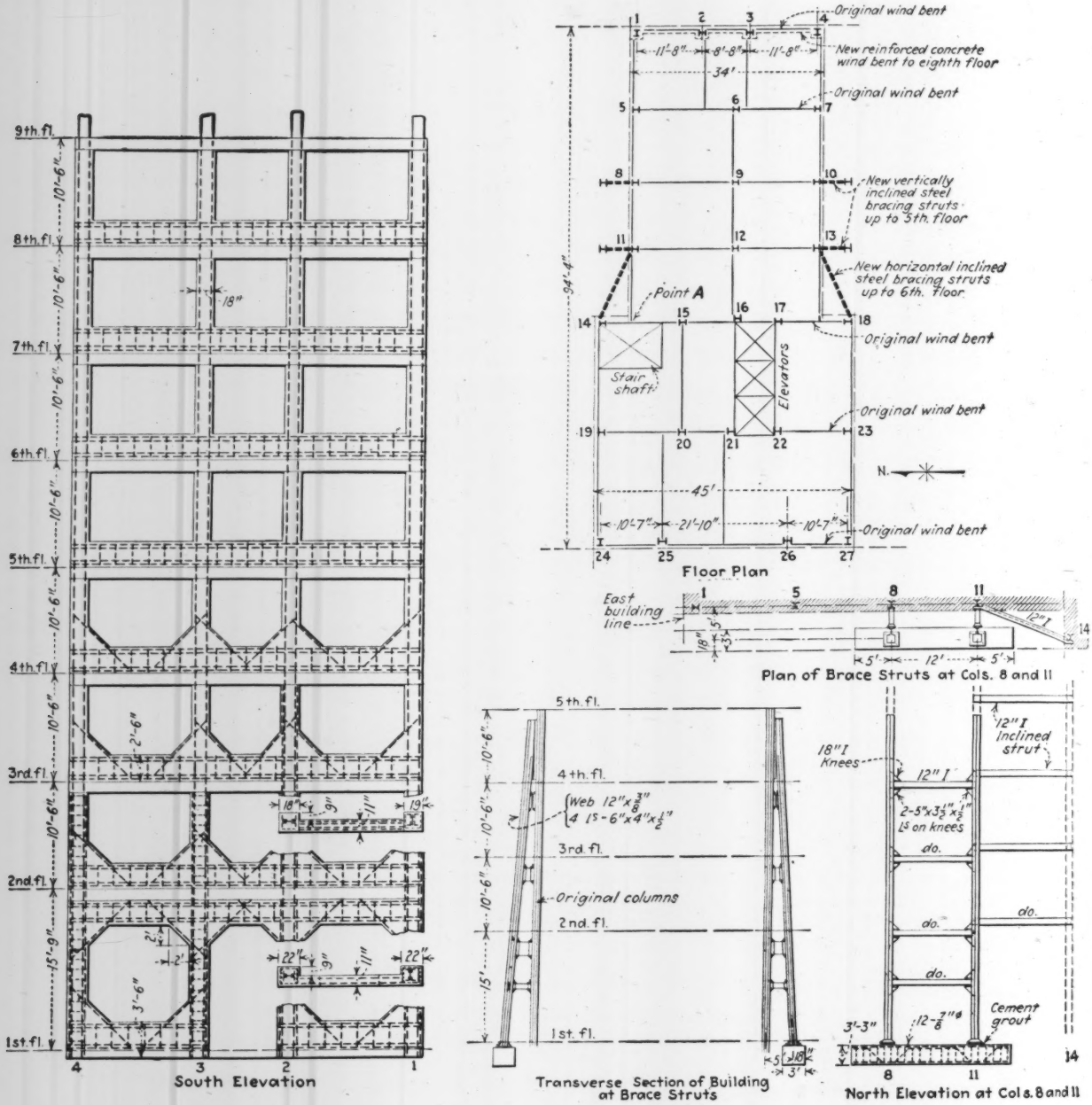


FIG. 5—REINFORCEMENT OF REALTY BOARD BUILDING

face. During the hurricane the effects of the wind forces were displayed by excessive vibration; broken partitions and walls were the result, as shown in the views Figs. 6 and 8. Great damage was done to the walls and partitions up to the ninth floor, while above this level they were in good condition. Comparing this fact with the good condition of the Meyer-Kiser Building above the tenth floor, we may conclude that ordinary standard beam connections with top and bottom angles are sufficient for buildings nine to ten stories high, with ratio of width to height about 1 to 2½; this corresponds to generally accepted practice as to omission of extraordinary wind-bracing.

Before a decision was reached as to what should be done with this building after the storm, I reviewed the wind stresses and design, and found that the steel frame was properly designed for a wind load of 20 lb. per sq.ft., which corresponds to a wind velocity of about 70 m.p.h. The design conforms to the Miami building code requirements. The hurricane at its peak had a wind velocity of about 120 m.p.h., corresponding to a force of about 60 lb. per sq.ft., and in gusts it reached velocities as high as 150 m.p.h. It is readily seen from these figures why excessive vibration took place.

In the floor plan (Fig. 5) it will be observed that the transverse wind bents in the original design were placed at Cols. 1-4 (east face), 5-7 (the line of columns next adjoining), 14-18 (fifth bents from the east, at the junc-

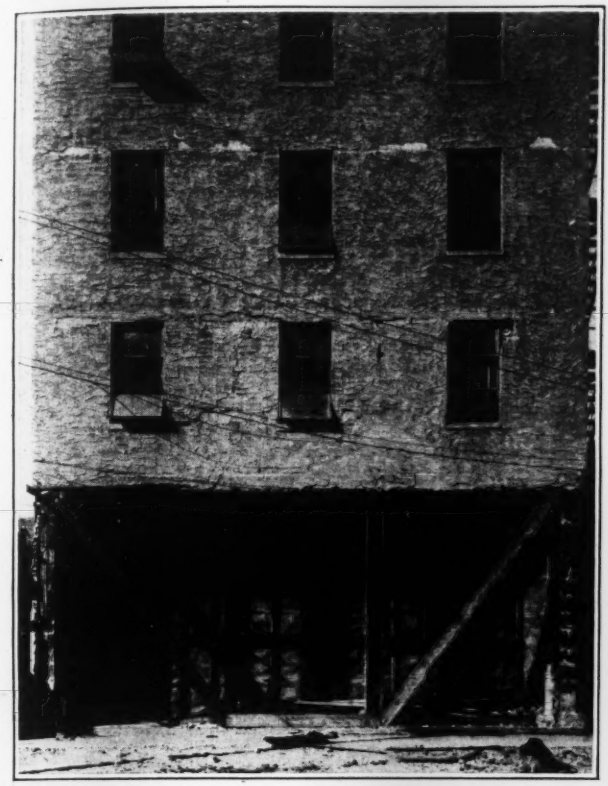


FIG. 6—REALTY BOARD BUILDING, MIAMI, REAR WALL, CRACKED AT EACH FLOOR GIRDER UP TO 10TH FLOOR

Wall in the first story was removed after the hurricane and timber diagonal braces set for temporary stiffening.

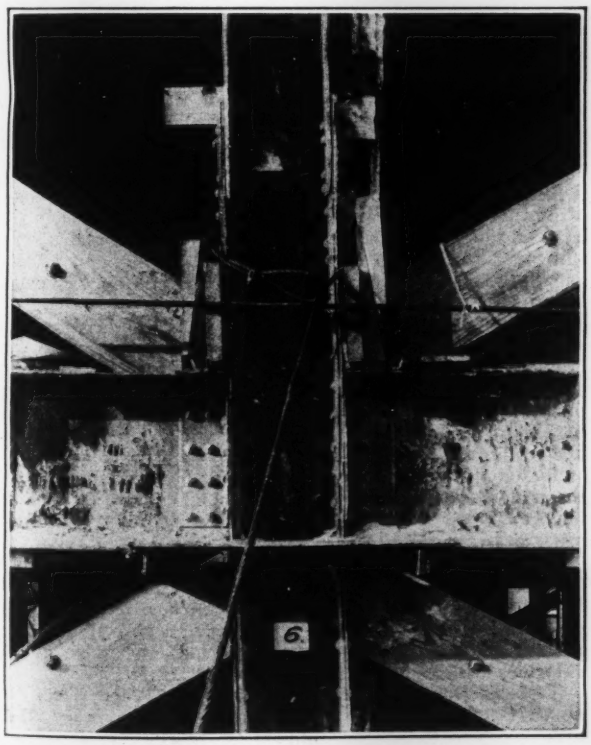


FIG. 7—TYPICAL BENDING OF FRONT-WALL COLUMNS OF MEYER-KISER BUILDING

View of sixth floor. Girders are straight but columns are bent above and below girder.

tion of narrow and wide parts of the building), 19-25 (the second bent from the west) and 24-27 (west front). No wind bents were provided in the transverse lines 8-10 and 11-13, presumably for architectural reasons. It therefore became necessary for the floor slab to transfer the wind pressure on the rear half of the building backward to the rear bents 1-4 and 5-7, and forward to bent 14-18. That it accomplished this transfer successfully is apparent from the undamaged condition of the floors. However, the load transfer manifested itself in a serious form at point *A*, near Col. 14 (Fig. 5), where the stair shaft walls were shattered up to the tenth floor. Evidently the beam extending from Col. 14 to Col. 15 lacked sufficient horizontal compressive or bending strength to transmit the accumulated wind shear at this point.

After giving this structure a great deal of study, I decided that the most feasible and economical means of adding stiffness to the frame was the provision of monolithic reinforced-concrete spandrel construction in the framework of the rear wall (bent 1-4), and provision of vertical and horizontal inclined steel struts to brace the outer columns of bents 8-10 and 11-13. This additional bracing is sketched in Fig. 5.

FIG. 8—FRONT CORNER OF REALTY BOARD BUILDING

When the building vibrated in the hurricane its southwest corner battered against the low adjoining building and broke away part of its coping.

The reinforced-concrete incasement of columns and spandrel beams in the rear wall extends from the ground up to and including the eighth floor. Cols. 8, 10, 11 and 13 are braced each by an outer bracing column placed in the side court and extending up to the fifth floor; intermediate connections tie the bracing column to the main column and form a strong portal system. The bracing columns have reinforced-concrete combined footings, as shown.

To take care of the load transfer at bent 14-18, which had caused the wall failure in the vicinity of point *A*, as already mentioned, horizontal steel struts were placed from Col. 11 to Col. 14, and from Col. 13 to Col. 18 at each floor level from the second to the sixth. It is believed that this construction will transmit any wind shear from the rear half of the building directly to the line of Cols. 14 to 24, thereby eliminating the observed weakness.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Study of Sewage Settling Tank Design

Sir—I have read with much interest the article by C. H. Capen, Jr., on "The Study of Sewage Settling Tank Design," together with your editorial thereon appearing in *Engineering News-Record* of Nov. 24, p. 833. The article contains much of interest, but probably owing to lack of space not sufficient data seems to have been given to substantiate certain of the conclusions reached.

It would seem desirable before the suggested method of rating the efficiency of settling tanks in terms of percentage of utilization of the settling capacity is generally accepted that it be demonstrated more clearly that this method is a true measure of tank efficiency. The true measure of settling tank efficiency is the percentage of the settleable solids that are removed by the tank and it is not apparent from the data given that the new method proposed gives results corresponding with the true figures.

In the extreme cases of high velocities, such as the recent measurements in the Winnipeg aqueduct by the salt velocity method the "flowing through period" (*Engineering News-Record*, April 28, 1927, p. 693) was considered the same as the "detention period," or as a settling tank the aqueduct would have 100 per cent efficiency which is of course absurd. Yet in a true settling tank it is possible by the use of baffles to approach this condition both as to "complete utilization of the settling capacity" and the low actual removal of settleable solids.

The table showing the Efficiency Rating of Settling Tanks at Sewage Works of Four New Jersey Towns appearing in Mr. Capen's article unfortunately gives but meagre information as to the true efficiency of the settling tanks in question as measured by the removal of the settleable solids. The two cases that appear at all comparable are the Philipsburg tank, when cleaned and operating under two different rates of flow. The results here, however, are not in support of the new rating method. Here tanks of a rated efficiency of 48 per cent gave a settleable solids removal of 81 per cent while under different conditions with an efficiency of 30 per cent the removal was actually greater or 89 per cent.

Under the heading of "Recommendation as to Design" it is interesting to note that an 8-hr. detention period is suggested for single-story settling tanks and a 2½- to 4-hr. period for an Imhoff tank, all of which is based presumably on the studies and observations cited. That is, the settling space in an Imhoff tank is considered to be from two to three times more effective per unit of volume than in other types. The outstanding difference between the settling chamber of the Imhoff tank and that of the plain flat bottomed tank is that in the Imhoff tank part of its capacity is in the more or less dead water space formed by the sloping bottom leading to the slots. This characteristic makes the Imhoff tank inherently less efficient as measured by "the complete utilization of its settling capacity," yet it is apparently not so considered.

In connection with the selection of settling periods up to 8 hr. it would be interesting to know what weight has been given to considerations of the effect of the longer periods on the quality of the effluent, particularly in reference to oders and troubles with gas lifted solids so familiar in the days of septic tanks.

Little exception can be taken to the general remarks under "Conclusions" except perhaps to go a little further with the observation that excellent removal of settleable solids has been secured in tanks of moderate detention periods when the length-width, ratio was less than 2.

Mr. Capen has done a service in advancing the data given, but it should be borne in mind that the function of a settling tank is to remove settleable solids and its efficiency should be rated on that basis. The actual time of passage of liquid through a tank is of little importance as long as in doing so it is capable of separating itself from the solids. To this end careful design is indeed necessary.

New York City,
Nov. 30, 1927.

RICHARD H. GOULD,
Sanitary Engineer.

Sir—Mr. Capen's article on the "Study of Sewage Settling Tank Design" contains some interesting information. The efficiency, or rather the inefficiency, of sewage settling tanks has been observed for many years, and although many engineers have attempted to improve designs by following either personal hobbies or inadequately proved schemes, the usual result has been to adhere to customary construction. The size of the tank, as Mr. Capen says, has generally been proportioned to the so-called detention period, having little regard to the flow-through-period. The employment of baffles has been largely upon the hit-or-miss plan.

Many engineers have had little or no patience with inspectors who have, by means of colored dyes, attempted to show the rapid passage of some parts of the flow through the tank, thereby indicating tank inefficiency because of the lack of time given to a portion of the flow for the settling of its suspended matter.

The method of testing the flow, described by Mr. Capen, may be superior to the use of dye, and the writer compliments Mr. Capen for taking up this matter and bringing it forcibly to the attention of designing engineers. Careful scientific study of this subject is needed followed by some real practical experimentation on a large scale, and if Mr. Capen's method proves to be satisfactory for a rapid means of testing, it will be most useful.

As to the conclusions drawn by Mr. Capen, the writer is not surprised. Nothing seems to appear which has not been recognized for a long time by most of our experienced and thinking engineers. That however, does not prevent a repetition of such facts from being profitable to us.

What we need is some one to tell us how to design tanks which will be efficient and tanks in which, as Mr. Capen says, "the ratio of the flowing-through period to the detention period is unity," or nearly so.

The writer therefore hopes that Mr. Capen's work will be appreciated and that his method of testing will become the means of stimilating others to improve on tank designs.

Harrisburgh, Pa.,
Dec. 2, 1927.

F. E. DANIELS,
Chief, Industrial Waste Section,
Pennsylvania State Department of Health.

Sir—I was much interested in Mr. Capen's article, "Study of Sewage Settling Tank Design." The article is timely and has considerable academic value, but there it contains some statements that might be misleading to the designers of tanks, and to those engineers who report on the efficiency of existing tanks.

In Conclusion 8, Mr. Capen states that, "Analyses for solids will not always agree with the efficiency rating, but are somewhat consistent." Is not the analysis for solids the true scale for measuring the efficiency of a tank for settling purposes? The writer's idea of an efficient tank would be one in which the most solids were settled out and removed, without nuisance, for the least capital and operating costs.

Sodium chloride, as a chemical agent for determining flow-through values, is superior to other salts, for it is less influenced in solubility by changes in temperature than other salts, and is easily titrated. However, the density or specific gravity of a solution of salt is usually greater than that of the sewage and in each case varies with the concentration. If the solution is injected near the surface at the influent end, the solution will have a tendency to sink through the sewage during the flow-through period, and some of the chlorides will be retained in the sludge.

Tests at Dallas on Imhoff tanks and at Waco, Texas, on an activated-sludge plant, show a consistent drop in chlorides, after repeated tests, from influent to effluent. This can only be explained by the theory that chlorides are retained in the sludge which, of course, does not appear at the effluent. Otherwise, all tanks should show an increase in chloride con

centration, due to the evaporation in tanks during the flow through period.

Osmotic and solution pressure would have a slight bearing on the results obtained by titration. There is a tendency for the molecules, after entering the liquid, to move in every direction and, consequently, a certain negative velocity or lag will appear by the use of salt solution, whereas certain dyes will diffuse to some extent, but will not show negative velocities except in the case of back water.

Mr. Capen's statement in Conclusion 7 that "velocity is unimportant" can not be applied generally. In an extreme case of a circular pipe being used as a settling tank, the flow-through efficiency would be maximum at high velocities and at the same time the settling would be at a minimum.

The writer has recently designed and constructed a settling tank for Jacksonville, Texas, having a detention period of 1 hr., and a length to width ratio of 1.5. This tank is consistently obtaining a removal of 90 per cent plus of 1-hr. settleable solids.

The detention period should be largely governed by the type of after treatment. Delayed detention increases the septicity of sewage and the floating sludge deposits, which are the prime cause of odors from settling tanks, and will react unfavorably with a following activated process.

The engineering profession could benefit by considering such subjects as sewage settling tank design, and all other single-unit designs, as simply a case history, and not as a general method to apply in all cases. That is the attitude aimed at by the medical profession in recounting their cases. From a philosophical standpoint, no two disposal plants should be of the same design, since the factors governing the design—local physical conditions, money available, and purification requirements—vary in every case, and since only one design can correctly satisfy the given condition, all plants to be correctly designed must be different.

The writer wishes to acknowledge Mr. Capen's article as a valuable contribution, and is of the opinion that more detailed study should be made on the science of settling sewage.

H. L. THACKWELL,
Consulting and Constructing Engineer.

Jacksonville, Texas,
Nov. 26, 1927.

Sir—It is evident from the foregoing letters of Messrs. Gould and Thackwell that the table of efficiency rating was not of sufficient size to prove some of the viewpoints of the writer.

Before and during the period of the tests an enormous number of analyses of all kinds were made, including, of course, numerous analyses for solids. Invariably the discrepancies from anticipated results were so noticeable that attempts to prove relative efficiencies of tanks by comparison of solid results were usually given up in disgust. For that reason the writer has always been very skeptical of solid results. This was indicated in the article by Conclusion 8. The results in the table were given for what they might be worth and, in spite of their inconsistencies, are much better than the average.

The whole situation was studied quite thoroughly at Phillipsburg, where tests of all kinds were made over a period covering several months. In this case a silk mill discharged various dyes into the sewer system a short distance above the plant several times a day. The tanks were used as settling units for the lime and electrically treated sewage from the direct-oxidation process. In spite of the extreme solubility of the dyes and the fact that they had been thoroughly dissolved for hours, the lime sludge in the tank when drawn out in a section in a huge glass pipette showed unmistakable color stratification. On more than one occasion this stratification was predicted as to exact arrangement of colors simply by keeping a record of the colors as they appeared.

There is no reason to doubt that the salt solution acts much the same as the dye. In two of the test cases an attempt was made to compare the probable volume of chlorides that should be found in the effluent. It was found that a considerable amount of salt was lost. This might cause the "negative velocity or lag" spoken of by Mr. Thackwell, but I am more inclined to accept Mr. Clifford's statement, quoted in my article, that "The forward movement of the solute does not differ appreciably from the molecules of the solvent." Certainly when the tests are all conducted on the same basis as these were, the results are all comparable. The loss of salt may be due to adherence or chemical combination of the salt to or with the settleable solids removed by the tank.

In one test that the writer knows of but did not see, a salt solution was introduced in an Imhoff tank and the percentage appearing at the outlet end was very small. It was found that the chloride content in the sludge compartment and *gas vents* had increased, thus proving that the salt had passed through the slots. Furthermore, tests with dye in Imhoff tanks showed exactly the same results, and the color in the *gas vents* was frequently deeper than in the tank effluent.

The objection raised by Mr. Gould to the noneffective apex volume of an Imhoff tanks is perfectly reasonable and has been repeatedly spoken of by Mr. Downes, who devised a special inlet whereby the common overflow inlet was changed to a deflecting inlet. The effect on the tank was very noticeable.

In defense of the recommended detention periods, it should be of prime importance to consider what the average conditions are under which each type of tank operates. The long period for one-story tanks seldom does any harm from the odor standpoint because such tanks are seldom followed by secondary units of the type that would cause nuisances. Many one-story tanks are allowed to accumulate solids up to 75 per cent of their volume. Certainly eight hours capacity is none too much under such conditions. It is all right to reply that such conditions should not be allowed to exist, but they are the rule rather than the exception. This is true in New Jersey in spite of the fact that the state has gone a long way to promote intelligent operation. It is interesting to note that Mr. Gould and Mr. Thackwell both mention successful cases of short detention period and a small ratio of length to width. However, the writer knows of cases in New Jersey where somewhat similar designs were unsuccessful, although it must be admitted that unintelligent operation was partly responsible.

It was not intended to convey the opinion that all tanks other than Imhoff tanks should have a detention period of eight hours. This figure was given for cases of the ordinary one-story settling tank. It is also quite obvious that the conditions of length and width called for are not met in the case of a circular tank such as the circular Imhoff or the Dorr tank. Nevertheless, it was stated that such tanks "can be made very efficient."

The criticism in regard to the case of a pipe line being very efficient but allowing no sedimentation are perfectly correct. The writer was fully aware that such criticisms could be made and had read many articles on the salt velocity methods used for determining pipe flows, particularly those of Mr. Groat, which were published in the *Transactions* of the American Society of Civil Engineers in 1914. However, a well informed engineer would never design a settling tank that operated under the conditions of a pipe line, and it has to be presupposed that the fundamental principles of design must be included before attempting an efficiency rating. An illustration exists in the case of one of the companies which installs small settling units for private houses, wherein the buildings to be served had a large number of occupants. The company applied to a body having jurisdiction for permission to install a number of small rectangular tanks in series., the effect being to create a high velocity with practically the same condition of flow as in a pipe line. The permit was denied on that basis, but, in spite of the arguments advanced, the company still insisted that series and not parallel operation was correct. That particular installation was not made, but there exist many others of identical nature, the extreme being a case of twelve such units connected in one series. These facts do not disprove the practicability of the efficiency rating, but merely show that it has to be used in conjunction with other established engineering principles.

The letter of F. E. Daniels hardly needs a reply. Mr. Daniels was at one time connected with the same Department for which the tests were made and was thoroughly familiar with the conditions that led to the investigation. It is not unreasonable to suppose that he or others may have

previously expressed ideas of a similar nature, particularly since it is obvious that Mr. Clifford worked on the idea twenty years ago and his publications must have struck a responsive chord in many places in this country.

The comments included in these letters are exactly of the type that were desired and they show that not all engineers are content to follow the old beaten path. The writer wishes to thank the contributors for their comments and believes that they have contributed to the subject under consideration.

East Orange, N. J.,
Dec. 13, 1927.

CHAS. H. CAPEN, JR.
Consulting Engineer.

Wisconsin Engineers Ask Whether Licensing is Advantageous

Sir—The question of whether to support or oppose the Licensing of Engineers in Wisconsin is being studied by a committee of the Engineering Society of Wisconsin, of which I am chairman. The committee is open-minded and anxious to reach a sound conclusion. Our study of published discussion reveals a lack of concrete and specific evidence upon which to base judgment. The committee desires, therefore, to get in touch with anyone who has something tangible to offer. We would like especially to learn about the merits and defects of licensing from individual engineers who are working under license laws. Perhaps some of your readers will have something to offer. Here are some of the questions for which we are seeking answers:

Are there *quacks* in the engineering profession; that is, are there men who do not possess a passable knowledge of mathematics, physics, and mechanics, but who, nevertheless, psas themselves off for engineers? Does anyone know of specific cases of quackery?

Has licensing, where introduced, actually and tangibly improved conditions for either the public or the engineer?

Has licensing, where introduced, adversely affected the condition of the engineer, either by imposing an appreciable financial burden, hampering free movement from state to state, imposing a barrier to worthy young men who want to enter the profession, or in any other way?

Madison, Wisconsin,
Nov. 25, 1927.

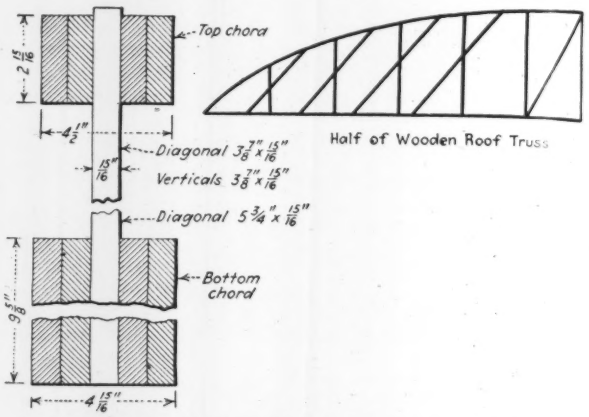
L. F. VAN HAGAN,
Professor of Railway Engineering,
University of Wisconsin.

Wooden Skating Rink Roof Truss Fails Under Snow Load

Sir—On November 24 in the village of Newberry, Mich., a wood frame skating rink collapsed under a snow load of 4½ inches of rain-soaked snow. The load was about 6 lb. per sq.ft. There was fortunately no loss of life since the skating season had not opened. The present size of the skating enclosure was about 60x120 ft., with the length north and south. Along the entire length of the west side was a lean-to structure divided into lockers and waiting rooms. The main structure was divided into panels by a system of trusses supported on posts. There were about 12 panels. The trusses had a curved top chord and a horizontal lower chord, as shown in the accompanying sketch. The trussing between the upper and lower chord was curious in that the diagonals while intersecting the verticals at about mid-height, did not have their center line intersect the center line of the verticals on the center lines of the top and bottom chords, but below the lower chord and above the upper chord center line. The spacing of the verticals was about 2 and 4 ft., as I recall. The bowstring span was about 59 ft., the truss depth in the center about 7.7 ft., and the height of the lower chord about 10 ft. Purlins 2 in. x 5⅝ in. spaced about 2 ft., were used, on top of which was 1-in. sheathing and a heavy felt.

The entire roof, the east side and ends of the main building, are down, apparently from a combination of the effect of the snow load and a west breeze which swayed the top eastward. The roof fell vertically almost intact, the east and south walls falling outward.

During the time the building was used for skating it often contained 200 persons more or less. It had stood two seasons, probably because of exceptional weather, and because the roof was kept clear of snow by the wind. On one or two occasions, I saw men keeping the snow from plastering itself onto the west edge during a wet snow storm.



DETAILS OF BOWSTRING TRUSS SHOWING ARRANGEMENT OF DIAGONALS

At the time the rink was built, three years ago, I warned such persons as I thought might have influence that the building was not safe.

Newberry, Mich.,
Nov. 29, 1927.

R. R. RYAN.

Should Employer or Employee Pay Employment Agency Fees?

Sir—Among the several able articles and letters which have from time to time appeared in the columns of your journal anent the inadequacy of engineering salaries, there is one subject I have not yet seen broached, which in a way bears directly upon the salary question. I refer to the tendency among a considerable number of the engineering firms who are large employers to place whatever vacancies they may have in the hands of employment agencies. This is no doubt an excellent thing for the firms under discussion, since it relieves them of a large amount of clerical and secretarial work. But—and here's the rub—is it fair to expect the poorly paid employee to bear the cost of this service? It is, in a measure, tantamount to putting a premium upon a vacancy.

Take the case of the $200 a month man who has perhaps been unemployed for some weeks. Such a one, very often married, and with a family to support, faced with an accumulation of unpaid bills, for families must be fed even though the breadwinner is not working, obtains a position through one of the agencies, and immediately is up against the problem of paying away one-third or more of his first month's earnings. This is a condition which should not be tolerated. Since the employer is saved the extra work involved, let the employer pay.

There is also the point, of value to the employer, that when he places his vacancy in the hands of an agency he reaches only a limited proportion of those who might be qualified to fill it.

ANOTHER STRUGGLING ENGINEER.

Port Colborne, Ont.,
December 20, 1927.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Toe of Cofferdam for Hudson Bridge Fails; Three Drown

Section of Sheetpiling at Deep West Tower Structure Blows In—No Serious Delay

ON Dec. 23 the toe of a short section of the steel sheetpiling of one of the Hudson River bridge pier cofferdams at Fort Lee, N. J., blew in, overwhelming three of the men at work in the cofferdam. The structure in question was the northerly of the two cofferdams in which the two pier footings for the west tower pier of the 3,500-ft. Hudson River suspension bridge are being built. Each of the two cofferdams is about 100 ft. square. The south cofferdam had previously been pumped out, cleaned down to sound rock and concreted to within about 25 ft. of the water surface. The north cofferdam was pumped out only recently, and the landward half of the rock bottom was being cleaned off preparatory to concreting, when the blow-in occurred.

Description of Cofferdams

These cofferdams are in water ranging from about 40 ft. depth at the landward edge to 65 or 70 ft. depth on the river edge, measured from water surface to rock. The rock is Triassic (Newark) sandstone, with irregular surface sloping down eastward, and was originally overlaid with rock fragments and river mud, to a water depth of 10 to 20 ft. The cofferdams were constructed by dredging the site down to a depth of about 40 ft. and then driving steel sheetpiling around a completed assemblage of bracing consisting of five or six horizontal frames with heavy steel H-beam walers along the sheeting and double 12x12 struts in both directions, spaced 15 to 20 ft. apart horizontally. The sheet pile wall of the land side and about one-fourth of the width of the upstream and downstream sides was single-wall, while the remainder of the periphery was double-wall construction, 5 or 6 ft. wide, whose cells were filled with clay except that the lower 20 ft. of the cells on the river side was filled with concrete to stiffen the cofferdam structure between the rock surface and the lower tiers of bracing. All piles were driven down hard, to penetrate the upper layers of rock where possible.

After completion of the cofferdam it was pumped down, the landward half of the rock surface was cleaned off and concreted, and then excavation completed in the wedge-shaped deeper part toward the river, and this also concreted.

After successful completion of this work in the south cofferdam, the north cofferdam, which had been making somewhat slower progress, was at the stage of cleaning off the loose and soft upper layers of rock preparatory to concreting the landward half. At the westerly end of the north wall, where the structure consists of only a single line of sheeting, the excavation of the bottom had gone down some 4 ft., inside of a berm about 5 ft. wide which was left along the foot of the cofferdam wall. The sheetpiles here were seated a foot or two in the bottom, so that the body of the excavation was two or three feet below the pile points. The lowest tier of bracing was 6 or 8 ft. above. Without warning, the lower ends of the piles in this part of the wall were forced in by the water and soil pressure outside, apparently shearing off the material of the berm and admitting a large rush of mud and water. Some of the men were able to reach the ladder to the top, but three were caught.

It is expected to drive an outer wall of sheeting at the point of the blow, filling the cells with firm material, to seal the leak before pumping out is attempted. No serious delay to the work is expected and the general plan already successful in the south cofferdam will be followed.

No Agreement Reached on Price of Colorado River Power

Conferences that were held daily in San Francisco starting Nov. 21 between members of the Colorado River commissions of the states of Arizona, Nevada and California, their state engineers, consulting electrical engineers and other advisors in an effort to determine what price Arizona and Nevada should receive from California for hydro-electric power to be generated if and when Boulder Dam is built, were terminated Dec. 17. At the close of the conference it was stated that while California had offered to pay a higher amount than its previous offer of four-tenths of a mill a kilowatt-hour made at the last Denver conference, the figures had proved unacceptable to Arizona and Nevada. The price named by California was not made public. At the Denver conference last fall one mill a kilowatt-hour had been asked by the other two states.

At Denver on Dec. 19, representatives of the four states of the upper basin of the Colorado River adopted a resolution opposing passage of any legislation proposing the construction of a dam at Boulder Canyon or any other development pending the outcome of negotiations among the three lower basin states, Arizona, California and Nevada.

Committees Offer Preliminary Data On Flood Control

Engineering Groups Meet to Advise House Committee on Control of Mississippi River

DURING the past week several engineering groups at the request of Chairman Reid of the flood control committee of the House of Representatives conferred with that committee to advise it on the subject of Mississippi River flood protection.

A committee of the American Society of Civil Engineers, appointed under a resolution of the Board of Direction passed at the Columbus meeting in October, met under the chairmanship of President John F. Stevens. The committee included J. Waldo Smith, of New York, J. W. Billingsley, of New Orleans, John F. Coleman, of New Orleans, Morris Knowles, of Pittsburgh, J. B. Galloway, of San Francisco, and D. W. Mead, of Madison.

Am. Soc. C. E. Committee

After reviewing the reports of General Jadwin and of the Mississippi River Commission, as well as the reports of the separate boards which had advised these authorities, the committee drew up a series of questions for use in the House hearings, to bring out the facts relating to various phases of the Mississippi floods and the protection systems proposed by the Chief of Engineers and the Mississippi River Commission respectively. A general report accompanying these questions recognized the great speed with which the official investigations of the last six months had to be conducted, but called attention to the unexplained differences of plan and estimate between the two proposed protective systems. It also suggested that full costs (including land, damages and incidental costs) should be compiled to enable various protective systems to be fairly compared. Immediate prosecution of mapping, the establishment of a hydraulic laboratory, and energetic prosecution of all the protective work that can now be determined upon as part of the final comprehensive plan, were recommended; but it was recommended that the surveys should be placed in the hands of the regular survey bureaus of the government, and that the laboratory be placed in the Geological Survey. Fuller study of the entire protection problem was called for as a prime essential to the adoption of a definite project.

A committee of university professors appointed by the presidents of a number of technical universities at the re-

quest of Congressman Reid also reviewed the flood control reports. This committee included Profs. B. A. Etcheverry, of the University of California, W. B. Gregory, of Tulane University, H. W. King, of the University of Michigan, Daniel W. Mead, of the University of Wisconsin, Clark E. Mickey, of the University of Nebraska, Harry Rubey, of the University of Missouri, Arthur N. Talbot, of the University of Illinois, Francis P. Witmer, of the University of Pennsylvania, and Sherman M. Woodward, of the University of Iowa.

UNIVERSITY PROFESSORS' REPORT

In its report this committee pointed out the essential change of attitude toward flood control represented by the reports of the Chief of Engineers and of the commission, and suggested that the basis for this change of policy should be fully set forth. A detailed review of the project was not attempted in view of the absence of a sufficient amount of detail in the report. The committee suggested, however, that immediate action is necessary to provide at least the same degree of security as before the flood of last spring, and to carry on such other work as will fit into an ultimate plan. At the same time that this work is going on, extensive study and investigation of the entire problem are necessary, in the committee's opinion, including study of the possible magnitude of future floods and the economic degree of security to be provided. The difference of cost estimates by the Mississippi River Commission and General Jadwin was pointed out as requiring explanation, and as warranting a more precise and detailed statement of costs, including all elements of cost involved, not merely construction but also right-of-way and the like. The committee indicated that such analysis of cost and the associated studies might suggest essential modifications of the plans now proposed. The committee also questioned the advisability of building "fuse plug" levees at the heads of the floodways, and expressed the opinion that all elements of the protection system should function in definite manner. It proposed an engineering board of review for the flood projects, and outlined the essentials of a sound administrative plan, based on continuing the Mississippi River Commission in charge of the work.

Hearings by the House committee are expected to begin on Jan. 5.

Three Short Courses for Sewage-Works Operators

Three short courses for sewage plant operators will be given Jan. 16 to 27 at Rutgers University by the College of Engineering in co-operation with the New Jersey Sewage Works Association and the State Department of Health. Course I is a prerequisite to Course II and Course III is an advanced course. Details of the course may be had from Dean Edward H. Rockwell, Engineering Building, Rutgers University, New Brunswick, N. J.

Chicago Prohibits Parking

By a vote of 37 to 4 the city council of Chicago has passed an ordinance which prohibits all parking of automobiles in the loop or business district between 7 a.m. and 6:30 p.m. on week days. Taxicabs will be allowed at specified cabstands. This much-discussed plan will go into effect on Jan. 2. Some merchants objected on the score of losing trade, but a traffic survey at stores indicated that less than 2 per cent of the customers came from parked automobiles. On the other hand, it is estimated that the greater freedom of movement under the new system will not only expedite traffic but will increase patronage by automobile riders who now keep away on account of the congestion and traffic difficulties.

S.P.E.E. Announces New Widespread Investigation in Engineering Education

The Board of Investigation and Coordination and the staff of the Society for the Promotion of Engineering Education have announced that through the creation of a special fund, a parallel project to the investigation of engineering education recently conducted by the colleges will soon be undertaken. The investigation is made through the provision of $30,000 by certain educational institutions and the Carnegie Corporation. The new inquiry, as stated in the proposals which form the basis of the grant, is to be directed toward the following ends:

1. To indicate the character and the extent of the need in the United States for a type of technological education having the following general characteristics: (a) More advanced than the work of the secondary schools; (b) affording a general preparation for technical, supervisory and commercial services in industry, rather than specific training for skilled trades and occupations; (c) differing from the programs of the engineering colleges by being briefer, more intensive and more direct in method, less theoretical and more strictly technical in content and not leading to an academic degree; and (d) principally full-time and co-operative day courses, but not excluding evening and extension courses organized into extended curricula.

2. To indicate the extent and character of the present facilities for giving education of this character and to appraise their effectiveness.

3. To indicate the means by which the needs may be met more adequately.

4. To indicate how institutions giving this type of technological education and the present engineering college may supplement each other so as to create a well-balanced system of higher technical education.

5. To indicate how the public educational authorities, the professional societies of engineers and industrial bodies may aid in establishing this type of education on a stable and adequate basis.

In defining the scope of the inquiry, attention was directed primarily to a type of education, rather than a type of institution. It is recognized that the field of specific training for crafts, trades and industrial processes, not commonly classed as forms of engineering activity, is of great importance, but that it warrants separate investigation under other auspices. A certain overlap is found between that field and the area of the projected inquiry, but training for engineering activities is the end of the specific inquiry in view.

In line with the policy pursued in other investigations by the society, a special advisory committee will be constituted, representing the interests most directly affected. The project is expected to extend through the year 1928.

Report Lists Sites for Airports in New York City Area

The fact-finding committee appointed by Secretary Hoover to study and report on airport facilities for the New York area made its report Dec. 20. Six sites were recommended as follows: A 300-acre tract near Middle Village, Queens Borough; the site where the city of Newark is now building an airport; the Bronx-East River area; the Hackensack Meadows area; Jamaica Bay area; and the Wall St.-Brooklyn area, which is Governors Island.

The report was made at a luncheon held under the auspices of the Merchants Association, the meeting being presided over by William T. McCracken, assistant secretary of commerce for aeronautics, who was chairman of the committee.

Water Resources Survey Before Congress

A bill providing for complete survey of the country's water resources was introduced in Congress on Dec. 20 as House Bill 8111, by Congressman Newton. One of the immediate objects of the proposed survey is a study of flood conditions. Control of streams has been handicapped by lack of basic facts, especially with respect to the magnitude of flood discharges and the average interval of time between floods of any given magnitude. There is need for more information as to the total quantity of runoff and the times and quantities of discharge at maximum, mean and minimum stages. The same information is needed also in connection with the design, construction, operation and administration of all works for utilizing the surface waters of the country.

Under the terms of the Newton bill the Geological Survey is authorized to collect the necessary information and prepare an inventory of the nation's water resources. An appropriation of $400,000 for the current year and $500,000 in each of the following 19 years is authorized by the bill.

Attempts Continue to Get Lines Under Sunken Submarine

Attempts continue to get lines under the S-4, U. S. Navy submarine which sank on Dec. 17 when rammed by the U. S. Coast Guard cutter Paulding off Provincetown, Mass., carrying 40 officers and men to their deaths. The submarine lies on the ocean floor at a depth of about 100 ft. and in mud about 12 ft. deep. Divers using jetting hose with special head are endeavoring to tunnel underneath the hull in order that cables may be placed for raising the submarine with pontoons. Tunneling on the starboard side had been about half completed on Dec. 27 when diving was discontinued because choppy seas had dragged the anchor of the diving ship Falcon. Lieutenant-Commander Ellsberg, who successfully raised the S-51, is in direct charge of the operations on the S-4.

The S-4 was returning to its base from a trial trip after some reconditioning when rammed. The Paulding continued to its base, though badly damaged. Navy surface craft and divers were in communication with six men in the S-4 for more than three days, first by oscillating devices, and then by actual code tapping on the hull of the sunken submersible.

Unlicensed New York Engineers Face Legal Involvement

According to a letter recently sent all engineering societies in the state of New York, the attorney general will proceed against all engineers who are not duly licensed to practice or who have failed to renew their certificates as provided by Article 55 of the Education Law. Up to this time it was considered expedient to refrain from pushing the matter of legal procedure against unlicensed engineers, thereby giving them ample time to become familiar with the law and its requirements. However, inasmuch as several years have elapsed since the passage of the act, the attorney general's office has been requested by the Education Department of the state of New York to proceed against all delinquents.

Street Sanitation Officials to Meet in Detroit

The eighth conference of the International Association of Street Sanitation Officials will be held at Hotel Statler, Detroit, Mich., Jan. 9 and 10. Among the topics and speakers are: street cleaning, Elmer C. Goodwin, examining engineer, Department of Street Cleaning, New York City; final disposition of ashes and miscellaneous refuse, W. J. Galligan, Bureau of Streets, Chicago; snow removal, George W. Dies, street commissioner, Toronto, Ont.; street designs from a sanitary viewpoint, W. C. Earle, city engineer, Pasadena, Calif.; and financial possibilities of salvage, Capt. Harrington Place, engineer, Detroit Bureau of Governmental Research, Detroit, Mich.

Road Show, Convention Managers Expect 30,000 At Cleveland, Jan. 9-14

Returns received by the managers of the convention and road show at Cleveland Jan. 9-14, 1928, of the American Road Builders Association indicate that both will exceed in attendance and interest those of any previous years. About 30,000 are expected to be in attendance during some period of the exhibition and the technical meetings. The numbers of exhibits will be increased by having available some 60,000 sq.ft. more of space than was available last year.

In accounting for their expectations the convention and exhibition managers point out that the convention in Cleveland may be styled a bigger and better gathering due to three main reasons: the increased attendance by the Pan-American contingent, participation by the newly organized county highway officials, and the fact that the Cleveland auditorium affords 150,000 sq.ft. of floor space as against the 90,000 sq.ft. that were available last year.

The county highway officials were organized last June by Thomas J. Wasser who is the first president of the organization. Thursday, Jan. 12, will be County Officials' day. On this day the first national session of county highway officials ever held will convene in the Hollenden Hotel. The response to Mr. Wasser's invitations to county highway officials throughout the country to be present, indicates that all sections of the country will be represented.

Not only are the nations of South and Central America taking a more active interest than ever before, but a large number of them are sending delegations to the convention accompanied by elaborate exhibits. Mexico is sending a delegation of three men with an exhibit of the Mexican National Highway System and other things of interest in that republic.

Cuba, likewise, will participate in a similar manner. Other nations will send official representatives and in addition will participate in the presentation of foreign exhibits for the inspection of all American road builders.

Chicago Gets Traffic Commission

Following the recommendations of a city traffic report made last year and noted in *Engineering News-Record*, Feb. 3, 1927, p. 193, the Greater Chicago Street Traffic Commission has been organized by representatives of the city, county and park boards. The personnel of the commission is: President, R. W. Wolfe, commissioner of public works; vice-president, James Simpson, president of Chicago Plan Commission; secretary, Leslie J. Sorenson, city traffic engineer. Committees have been appointed to prepare uniform systems of traffic signals and traffic regulations, while a committee of police officers will arrange for uniform enforcement of the regulations.

Everglades Tax Law Is Declared Void

Circuit Court Judge Love, of Florida, on Dec. 14 declared unconstitutional the new state tax law passed last spring to place the Everglades drainage work on a stronger financial basis. The law authorized the levy of an *ad valorem* tax on land in the district, in addition to benefit assessments as heretofore. This provision was made to meet the views of bond buyers that more security should be placed behind Everglades drainage bonds in order to bring down interest and enable larger issues to be sold.

After the passage of the law, property owners in the Everglades assessment district sued, claiming that their lands, being not marshy or subject to benefit by Everglades drainage, could not lawfully be taxed on its value. The present decision upholds this view. The state plans to appeal.

Everglades work has been conducted only on a small scale during the past year, pending a decision on the validity of the tax law.

Pittsburgh Gasholder Explosion Found Accidental

On Dec. 21 a coroner's jury verdict on the explosion of the 5,000,000-ft. gasholder in Pittsburgh on Nov. 14 found that the explosion was accidental, and resulted from leakage of the valves which separated the holder from the supply mains. The verdict recommended, however, that authoritative general safety rules for conducting repair work on gasholders be drawn up.

The holder belonged to the Equitable Gas Company, a subsidiary of the Byllesby Company, of Chicago, and served for storage of natural gas. It had been in process of repair for several weeks before the accident, the Riter-Conley Company doing the repair work in conjunction with forces of the gas company. Two valved pipes connected the holder to a system of mains; the valves in these pipes were closed, but the pipes were not disconnected during the repair work. After the explosion the valves were tested and one was found to leak slightly although no evidence of gas had been found in or about the holder before the morning of the explosion.

At the time of the explosion the holder bell had been raised partway by blowing in air, a total of about 650,000 cu.ft. From the gas leakage measured after the explosion, it was estimated that about 40,000 cu.ft. of gas entered the holder. Ignition was brought about by a welding torch which was being used on the outside of the holder bell.

Railway in Texas Oil Field

The Texas-New Mexico Railway Company has been authorized to build a new railroad line from Monahans in Ward County, Texas, through Kermit and Winkler Counties to the Texas-New Mexico boundary line, a distance of approximately 35 miles.

Personal Notes

J. G. TRIPP, until recently engineer of construction on the Lake Pleasant Dam, has taken charge of the construction work on the Coolidge Dam for Atkinson Kier Bros. Spicer Company, the general contractors. Mr. Tripp is a graduate of the Massachusetts Institute of Technology and has had varied experiences on dam construction, having been employed on the Little Rock Dam at Palmdale, Calif., and the Emigrant Creek Dam at Ashland, Oregon.

F. C. HART, until recently assistant project engineer for the Missouri Highway Department, has been appointed resident engineer on bridge construction by the Arkansas State Highway Department.

HAROLD A. THOMAS, professor of hydraulics in the Department of Civil Engineering at Carnegie Institute of Technology, has been appointed hydraulic engineer for the city of Pittsburgh. His appointment was made by the Department of Public Works. His work will be concerned with studies of flood heights relative to a relocation of boulevards along the rivers, and other construction changes recommended by the City Plan Commission.

DR. H. N. BUNDESEN, until recently health commissioner of Chicago, has been appointed director of health of the Sanitary District of Chicago.

JAMES E. HENDERSON, until recently assistant engineer in the construction department of the Florida East Coast Railway Company, has resigned to accept a residency with the Arkansas State Highway Department. Mr. Henderson was employed on double-track work of the Florida East Coast. For five years prior to his going to Florida, he was connected with the South Carolina State Highway Department.

C. E. DOUGLAS has resigned as city manager of Dubuque, Iowa, his resignation to be effective Feb. 1, 1928. Mr. Douglas was formerly city manager of Newport News, Va., and succeeded O. E. Carr, who is now city manager of Fort Worth, Texas.

HAROLD E. WESSMAN, until recently structural designer with Waddell & Hardesty, consulting engineers of New York, has accepted an appointment in the Department of Civil Engineering at the University of Illinois. Mr. Wessman is a graduate of that university.

H. W. FENNO, who has been division engineer at Chicago for the New York Central R.R., has been appointed engineer of maintenance-of-way with headquarters in Cleveland, Ohio, succeeding Charles Yoder, who died recently.

G. TORNES has been appointed general supervisor of buildings in the engineering department of the Chicago, Milwaukee & St. Paul Ry., succeeding the late N. H. La Fountain.

Engineering Societies

Calendar

Annual Meetings

INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS, Chicago, Ill.; Annual Conference, Detroit, Mich., Jan. 9-10, 1928.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 18-20, 1928.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 23-27, 1928.

NATIONAL ASSOCIATION OF BUILDERS' EXCHANGES, Washington, D. C.; Annual meeting, Miami, Fla., Feb. 6-9, 1928.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Monday, Feb. 14-16, 1928.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Convention, Philadelphia, Feb. 28, 29 and March 1, 1928.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Convention, Chicago, March 6-8.

THE INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS has a long program of subjects for general discussion at the annual convention at Detroit, Mich., Jan. 9 and 10. The list is as follows: Street cleaning, E. C. Goodwin, New York, and W. J. Walsh, Minneapolis, Minn. Sewer maintenance and catch basin cleaning, E. E. Paffrath, St. Louis, Mo. Destroying and cutting weeds, A. B. Cook, Charlotte, N. C. Disposal of ashes and refuse, W. J. Galligan, Chicago. Snow removal, Geo. W. Dies, Toronto, Canada. Rubbish and ash collection, M. S. Murray, Kansas City, Mo. Street signs, L. W. Herzog, Albany, N. Y. Street parking in relation to street cleaning, E. A. Wood, Winnipeg, Canada. Utility excavations in streets, Robert B. Brooks, St. Louis. Street maintenance and repairs, I. M. Goss, South Bend, Ind. Cure of littering of streets and alleys, Joseph C. Powers, Atlantic City, N. J. Street design from a sanitary viewpoint, W. C. Earle, Pasadena, Calif. Training street cleaning personnel, J. P. Soderstrum, Rapid City, So. Dak. Salvage, Harrington Place, Detroit, Mich. The budget in relation to street cleaning, F. J. Altvater, Denver, Colo. In addition, there will be a report from the committee on garbage disposal. The secretary is A. M. Anderson, 10 So. La Salle St., Chicago.

THE ASSOCIATED TECHNICAL SOCIETIES OF DETROIT, at the December meeting elected officers as follows for 1928: President, Major John P. Hallihan, chief engineer, Rapid Transit Commission; vice-president, L. E. Williams; secretary (re-elected), E. L. Brandt. This association, representing fifteen local organizations, has co-operated with different city departments in preparing specifications, selecting engineers for vacancies in various city committees and commissions, and in selecting personnel and equipment for the technical departments of city educational institutions.

THE DISTRICT OF COLUMBIA section of the American Society of Civil Engineers, the Washington Society of Engineers and the Washington Post of the Society of American Military Engineers held a special joint meeting Dec. 17 at the U. S. Chamber of Commerce auditorium. The feature of the program was "The Mississippi River in Flood" by Major John B. Gotwals, Corps of Engineers, U. S. District Engineer at St. Louis. The talk was accompanied with both moving pictures and lantern slides illustrating rescue work, flood scenes and river conditions during the spring flood period.

THE ENGINEERING INSTITUTE OF CANADA will hold its next annual meeting in Montreal February 14-15.

Obituary

LIEUT.-COL. HENRY S. SPACKMAN, former president of the engineering company which bore his name, and now the E. L. Conwell Co., Philadelphia, died Dec. 21 at the age of 61 years. Col. Spackman began his professional career with James W. Queen Co., Philadelphia. He was then successively employed by the Pennsylvania Railroad, on building construction for the state of Pennsylvania, by the Philadelphia Department of Public Works and by James H. Windrim as constructing engineer. In 1896 he helped organize and was a member of the firm of Lathbury & Spackman, which later became the Henry S. Spackman Engineering Co., engineers and consultants in physical and chemical analyses of structural materials. During the World War Col. Spackman was known chiefly for his work as chief of the cement section and as technical adviser to the Peace Commission.

D. W. BRUNTON, internationally known consulting engineer and inventor, known to the civil engineering profession principally through his work in tunneling and who had made Denver his home, died at the Mayo clinic at Rochester, Minn., Dec. 20, aged 78 years. Mr. Brunton had been in ill health several years. Mr. Brunton was born in Ayr, Ontario, June 11, 1849 and when 21 began his engineering apprenticeship under J. C. Buckley. He came to this country in 1873 and practically grew up in the mining industry of the West. With J. Vipond Davies and J. Wellington Finch Mr. Brunton was selected to locate the Moffat tunnel under James Peak in Colorado, now nearing completion.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Concrete Road Yardage

For November the square yardage included in concrete pavement contract awards according to the Portland Cement Association was 5,102,195 for roads; 2,614,285 for streets, and 267,979 for alleys; or a total for the month of 7,984,459 sq.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1927

Month	Roads	Streets	Alleys	Total All Classes
Jan....	2,656,118	1,504,059	75,352	4,235,529
Feb....	2,336,031	1,935,262	119,382	4,390,675
March.	5,134,974	3,866,102	298,667	9,299,743
April..	10,264,336	4,931,954	285,924	15,482,214
May...	8,234,755	5,601,627	397,220	14,233,602
June..	8,424,051	6,977,602	673,350	16,075,003
July....	7,298,618	4,903,789	412,721	12,615,128
Aug....	10,725,030	5,820,033	479,369	18,024,432
Sept...	6,872,398	4,365,135	343,270	11,580,803
Oct....	5,527,085	3,686,570	586,575	9,800,230
Nov....	5,102,195	2,614,285	267,979	7,984,459
Totals	72,575,591	46,206,418	4,939,809	123,721,818

Business Notes

PARADON MFG. CO., Arlington, N. J., announces the appointment of the Pacific Water Works Supply Co., Inc., Seattle, Wash., as its representative in the Pacific northwest. The Chemical Equipment Corp., Los Angeles, Calif., has been appointed in a similar capacity for the states of California, Nevada and Arizona.

C. H. KELLER, president of the CONTRACTORS' EQUIPMENT COMPANY, Detroit, has for practically two years been operating an aeroplane in his travel to the plants of manufacturers whom he represents. The first year Mr. Keller, it is stated, covered between 15,000 and 20,000 miles by air, and this year will exceed this mileage. Recently Mr. Keller completed a 3,000-mile trip which took in stops at Chicago, Peoria, Cedar Rapids, Minneapolis, Oshkosh and back to Detroit.

HARNISCHFEGER SALES CORP., Milwaukee, Wis., announces the establishment of a branch office in Cleveland, Ohio, with J. T. Conners in charge.

C. N. THULIN, vice-president, Duff Mfg. Co., Pittsburgh, has taken over the supervision of the eastern sales district in addition to the western sales district of which he has been in charge for several years. W. G. ROBB has been appointed district manager of the New York district with headquarters in New York City. E. E. THULIN has been appointed district manager of the Chicago district with headquarters in Chicago. P. G. O'Hara, former vice-president in charge of the eastern district, has resigned to join the organization of the Vacuum Oil Co., New York City.

THE STUART S. SMITH CO., 19th and Indiana Sts., San Francisco, Calif., has been appointed by The T. L. Smith Co. of Milwaukee as distributors of Smith mixers and pavers for the northern California and western Nevada territories.

ROLLWAY BEARING CO., INC., Syracuse, N. Y., announces the opening of an office in Pittsburgh, Pa., in charge of Samuel Farrell, for several years with the company at Youngstown, Ohio.

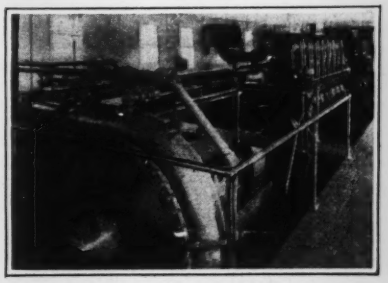
PENNSYLVANIA HIGHWAY DEPARTMENT has recently placed an order for 36 trucks from the Four Wheel Drive Auto Co., Clintonville, Wis. At the present time the Pennsylvania Highway Department has approximately 89 four-wheel-drive trucks in its service.

INDIANA TRUCK CORP., Marion, Ind., announces the appointment of Herbert H. Swiss as manager of its export department, with headquarters at the company's factory. Mr. Swiss was export manager for several years for the Republic Motor Truck Company, and served in the same capacity for the Ruggles Motor Truck Company for the past seven years.

New Developments

Diesel Dredge in Operation on New York State Barge Canal

A dredge has been added to the fleet in operation on the New York State Barge Canal powered with a solid injection diesel engine. The main unit is a four-cycle, single acting, De La Vergne vertical type, rated 500 b.hp.



ENGINE ROOM WITH DIESEL ENGINE CONNECTED TO 15-IN. PUMP

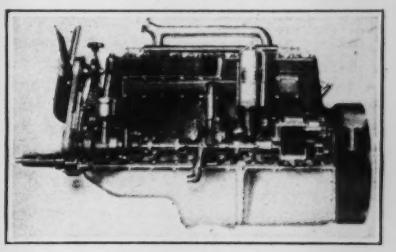
at 275 r.p.m. in eight cylinders, while the auxiliary unit is of three cylinders rated at 200 b.hp. at 277 r.p.m. Both engines have a 14½-in. bore and 18-in. stroke and are otherwise alike, thus greatly simplifying the matter of spare or repair parts. The speed of the main unit may be varied from the rated speed down to 90 r.p.m., through the aid of a throttle mounted on the governor column. A tachometer indicates the speed of the engine at all times.

Connected to the main unit through a heavy duty Francke flexible coupling is a 15-in. centrifugal dredge pump manufactured by the Morris Machine Co., Baldwinsville, N. Y. This unit is designed to handle 200 yd. of solids per hour when pumping to an elevation of 40 ft. through 2,400 ft. of 15-in. line.

The auxiliary engine drives a 130-kw. d.c. Westinghouse generator. Mufflers are installed in the exhaust line of each engine, while Reed air filters are used in the air inlet lines, the use of this latter equipment being found advisable as the dredge will often operate in sandy country. Engine jacket cooling water is circulated by motor-driven centrifugal pumps which take the water from the canal and pass it through the jackets after which it is run to waste overboard. Tanks, formed by bulkheads in the hull, hold approximately 32,000 gal. of fuel. The fuel system is equipped with jacketed lines and heating coils as well as duplex filters so that heavy fuel oil may be burned in the engines at any time.

New Line of Heavy-Duty Engines Designed with New Features

Seven bearing crankshafts, six cylinders in a single block, pump capacity of 70 g.p.m. to permit application of hot water heating systems, when used



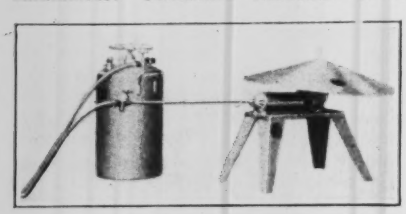
in bus service, are some of the features of the new line of heavy-duty engines put out by the Hercules Motors Corp., Canton, Ohio. This new line is known as the Y X series and is made in three sizes, all with 4¼-in. stroke, but with bores of 3¾ in., 4 in. and 4⅛ in. It is claimed by the manufacturers to be the first heavy-duty six-cylinder engine that will run continuously at high power at 1,800 r.p.m. Another new series of these engines, to be known as the W X, will shortly be put into production in which a stroke of 4¼ in. will be used with bores of 3⅜ and 3¾ in.

Careful consideration has been given in the design to accessibility and other factors making for ease of maintenance. Felt washers ordinarily used are eliminated, oil seals being provided at various joints. An oil filter of the built-in

type is used. Further operating security is afforded by a hood surrounding the oil pump which is so arranged that if the screen clogs for any reason, oil can be drawn up over the edges of the hood and the supply is still continued. Alloy steel is used to a large extent for the important parts. The cylinder block is a semi-steel casting containing 1½ per cent nickel. Piston pins and valve tappets are molybdenum steel, while the valves are of the one-piece type, the exhaust being silchrome and the inlet nickel-chromium metal.

Salamander Is Operated By Light Furnace Oil

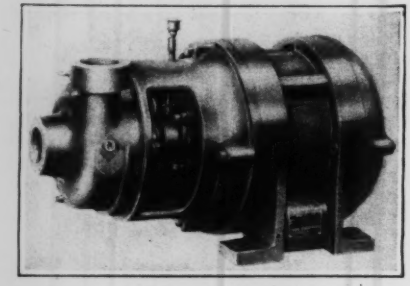
A new type salamander has recently been placed on the market by Littleford Bros., Cincinnati, Ohio, which is claimed to produce enough heat to replace from four to six salamanders of the old coke burning type. The new salamander consumes kerosene or a



light furnace oil for fuel. The unit is simple to operate, being controlled entirely by a single valve adjustment. There are no smoke and no fumes to injure workmen. It is said that when used indoors the heater will not mar plastered walls. The flame is entirely contained beneath the hood so that danger from fire is eliminated. A special pan is also provided under the burner to prevent any possibility of oil dripping on the floor. A further safety feature is the arrangement of the legs so that the salamander will not upset if bumped. The new oil burning salamander is made in two sizes. Fuel consumption for the No. 1 is about one-half gallon per hour and for the No. 2 about ¾ gallons per hour.

Compact Centrifugal Pump Units Designed in Small Sizes

The centrifugal pumping sets, type SSU, recently brought out by the Allis-Chalmers Manufacturing Co., Milwaukee, Wis., are combined motor and pump units of compact, substantial design. Both the pump and motor parts are built and guaranteed by the same manufacturer. The unit is close coupled



by fastening the pump impeller to one end of the extended motor shaft, the pump casing being bolted to a special integrally cast extension of one of the motor end housings. This arrangement is claimed to make the simplest possible construction and eliminates the base plate, coupling and pump bearings, at the same time assuring permanent alignment between the pump and motor.

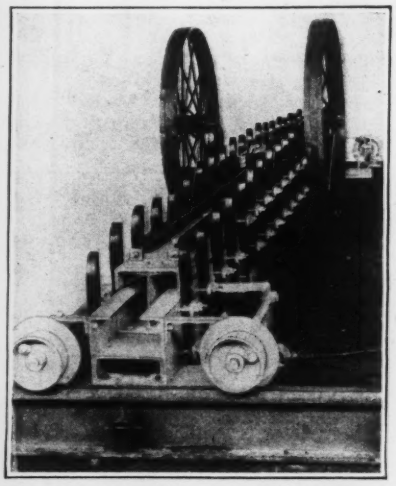
The motor bearings, which are the pump bearings as well, are of the oversize Timken tapered roller type mounted in dust and grease tight housings. The pumps are built in 1¼ in. x 1¼ in., 1½ in. x 1½ in., 2 in. x 2 in., and 2½ in. x 2½ in. sizes, and can be used with 1, 1½, 2, 3, 5 and 7½-hp. motors. The capacities handled range from 25 to 200 g.p.m. against heads of from 50 to 100 ft.

Diesel Operated Excavating Machines Announced

After experiments covering over four years, the Harnischfeger Corp. of Milwaukee, Wis., announces Diesel equipped excavators in 1 and 1¼ yd. sizes for shovels and draglines, and 1¼ and 1½ yd. sizes for rehandling clamshell service. The engines are of the full-Diesel four cylinder type and the fuel is injected mechanically. The engine may be started cold without priming or reheating. The manufacturers claim that the Diesel engine will take a sudden heavy load without slowing down as much as will a gasoline motor, and that it is this quality that makes the Diesel ideal for heavy duty work.

Subgrade Machine Operates On Road Form

There has recently been placed on the market by Ted Carr & Co., Chicago, a new subgrade machine known as a



true grade scarifier. It is adapted to run on the forms and scarify the subgrade to an exact depth for highway construction. It is claimed that the machine will cut high places from the hardest subgrades, it being designed so that before any scarifier tooth can raise from the ground, it is necessary to lift half of the weight of the two-ton machine.

The frame is adjustable to different widths of road from 16 to 24 ft., and carries 47 double-end plow-steel scarifier teeth. These are so arranged that there is ample room for earth to pass between them, while at the same time they come in a new path on the return trip so that they have scarified the ground every three inches. Wheels aided by lift springs are provided at the center to enable the operator to raise the machine preparatory to turning it around or taking it from the forms.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington, D. C.; Annual Convention, Detroit, Jan. 4-6, 1928.

ASSOCIATED EQUIPMENT DISTRIBUTORS, Milwaukee; Annual meeting, Cleveland, Jan. 6-7, 1928.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 16-19, 1928.

NATIONAL PAVING BRICK MANUFACTURERS ASSN., Chicago; Annual meeting, Chicago, Jan. 25-26, 1928.

New Publications

Road Rollers—ERIE MACHINE SHOPS, Erie, Pa., has published a pamphlet describing its new gasoline operated tandem road rollers. The pamphlet, besides giving a number of illustrations of the machine in various circumstances of operation, includes detailed specifications of the roller and its operating mechanism.

Uses for Inks—CHAS. M. HIGGINS & Co., Brooklyn, N. Y., has prepared a 20-p. book entitled "Techniques," giving a number of outstanding artistic treatments of present-day illustrations produced by means of Higgins' drawing inks, both black and in colors. The works of a number of important artists and illustrators are included. The booklet has been prepared primarily as an aid to the architect, draftsman and architectural student, showing what can be accomplished by use of the company's inks.

Asphalt Plant—F. D. CUMMER & SONS CO., Cleveland, Ohio, has published a 23-page booklet, describing its stationary and portable asphalt plants. The booklet is really a list of specifications for each type of plant accompanied by illustrations, both of the complete units, and of the special parts.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Publicly Owned Construction Projects Other Than Buildings Gained In 1927

Upward Movement Started In Spring of Current Year—Water-Works Alone Failed to Show Increase in Total Contract Value

THE total public contract awards for construction other than buildings during 1927, including November, amounted to $939,183,000 an increase of 16 per cent over the same period of 1926, according to statistics compiled by *Engineering News-Record*. The cumulated monthly totals through March of this year were slightly under last year, but beginning with April awards, 1927 has remained above the cumulated 1926 figures. Each month of 1927 has exceeded the corresponding month of 1926 except January, February, and July. June, 1927, was far ahead of June, 1926, about 60 per cent, while July of this year was only 30 per cent less than last year.

Of all awards, both public and private, 60 per cent has been for buildings during the eleven months of 1927. Only about 20 per cent of all public expenditures for construction is for buildings. The 80 per cent of non-building public contracts include waterworks, sewers, streets and roads, the majority of bridges and excavation and drainage projects, all Federal Government work and part of the general unclassified construction awards.

Waterworks awards during eleven months of 1927 are slightly less than last year but cumulated monthly totals showed this year to be in the lead at the end of March, June, and August.

Bridge contracts have exceeded 1926 since the fifth month by a conspicuous amount. Eleven months' total is about 65 per cent higher than the same period last year.

Construction of sewers has also gone ahead in larger volume than last year except for the first two months of the year. The total increase has been approximately 15 per cent over 1926 figures to December 1.

Cumulated totals of contracts for excavation and drainage work stands about 48 per cent higher than last year and in June, 1927, the totals were 150 per cent larger than during the first half of 1926.

Streets and roads have been contracted for in about the same amount each month as in 1926 and the eleven months' total for 1927 exceeds last year by only about 6 per cent.

Federal Government contracts are approximately at the same point as last year although totals through August and September of 1926 were considerably above 1927.

Unclassified public work has been contracted for in larger volume than last year by about 74 per cent. Thus it is seen that all classes of public construction except waterworks have been undertaken in 1927 in larger volume than last year.

Minimum in each class is described at the top of the following page.

PUBLIC BUILDING CONTRACTS COMPARED WITH CONSTRUCTION OTHER THAN BUILDINGS

(000 Omitted In Value)

	Public Contracts Excluding Building	Per Cent of Total Contracts	Public Building	Per Cent of All Public Contracts
1927				
January	$41,865	23	$22,574	35
February	29,775	17	13,374	31
March	84,093	31	13,490	14
April	84,031	34	18,274	18
May	110,666	39	16,184	13
June	145,335	41	24,469	14
July	68,825	29	20,483	23
August	97,069	34	29,816	24
September	124,918	39	19,095	13
October	97,009	39	18,700	16
November	55,597	22	16,073	22
	$939,183	32	$212,532	20
1926				
January	$50,698	26	$14,123	22
February	44,627	25	12,396	22
March	61,641	27	16,492	21
April	79,571	28	21,835	22
May	77,774	32	21,358	21
June	90,683	38	18,513	17
July	98,730	33	22,186	18
August	91,065	37	17,582	16
September	94,142	34	19,434	17
October	70,496	30	12,864	16
November	48,295	23	10,763	18
	$807,722	30	$187,54[illegible]	19

Work In Foreign Fields During the Last Half of 1927

THE following tabulation of important construction projects awarded to American contracting firms, during the last six months of the current year, was compiled from items which appeared from time to time in the Construction News section of *Engineering News-Record*. The majority of the foreign jobs let during the half-yearly period were awarded by the Navy Department. The Lake Tsana dam ($20,000,000) awarded by the Abyssinian Government, was by far the most outstanding foreign project of the year. Canadian contracts are not included in the accompanying table. Totals for the Dominion, however, appear regularly, by classes, in the first issue of each month.

FOREIGN CONTRACTS AWARDED DURING THE LAST HALF OF 1927

Project	Date of Issue E.N-R.	Location	Owner	Contractor	Value
Barracks	July 7	Guantanamo, Cuba	Bureau of Yards and Docks, Navy Dept., Washington, D. C.	Donnell-Zane Co., New York, N. Y.	$13,828
Gasoline tank	Sept. 1	Guantanamo, Cuba	Bureau of Yards and Docks, Navy Dept., Washington, D. C.	Austin Eng. Co., Inc., New York, N.Y.	10,200
Power plant	Sept. 8	Tokio, Japan	Nippon Elec. Co	H. K. Ferguson Co., Cleveland, O.	300,000
Hospital	Sept 22	Oahu, Hawaii	Schofield Barracks, U. S. Army	R. R. Ames, Honolulu, H. T.	229,000
Tanks	Oct. 27	Aruba, Dutch West Indies	Anglo-Mexican Petroleum Co., Ltd. (Royal Dutch-Shell)	Chicago Bridge & Iron Works, Chicago, Ill	.....
Chimneys	Nov. 3	Pearl Harbor, Hawaii	Bureau of Yards and Docks, Navy Dept., Washington, D. C.	Weber Chimney Co., Chicago, Ill.	15,365
Dam and highway	Nov. 17	Lake Tsana, Abyssinia, Africa; road from lake to Addis Ababa	Abyssinian Government	J. G. White Eng. Corp., New York N. Y.	20,000,000
Sugar cane mill	Nov. 17	Tarlac Province, Philippine Islands	Compania General de Tabaco de Filipinas, Barcelona, Spain	General Elec. Co., Schenectady, N.Y. and U. S. Steel Corp., New York, N.Y.	2,000,000
Factory and warehouse	Nov. 24	Yokohama, Japan	Ford Motor Co., Detroit, Mich	H. K. Ferguson Co., Cleveland, O.	1,000,000
Officers quarters	Nov. 24	Cavite, Philippine Islands	Bureau of Yards and Docks, Navy Dept., Washington, D. C.	J. E. Grant, Manila, P. I.	30,000
Quarters	Dec. 8	San Juan, P. R., U. S. Naval Radio Station	Bureau of Yards and Docks, Navy Dept., Wasnington, D. C.	Benitez & Gautier, Santurce, P. R.	9,500
Barracks	Dec. 8	Pearl Harbor, Hawaii	Bureau of Yards and Docks, Navy Dept., Washington, D. C.	C. A. Blume, San Francisco, Calif.	444,415
				R. E. Wooley, Honolulu, H. T.	108,000
Generating plant equipment	Dec. 15	Pearl Harbor, Hawaii	Bureau of Yards and Docks, Navy Dept., Washington, D. C.	Grace Bros. & Co., Honolulu, H. T.	$18,990
Refrigeration plant	Dec. 15	Pearl Harbor, Hawaii	Bureau of Yards and Docks, Navy Dept., Washington, D. C.	Von Hamm-Young Co., Ltd., Honolulu, H. T.	14,175

This Week's Contracts—With Comparisons

Minimum costs observed are: $15,000 for water-works and excavation, drainage, irrigation, levee, river and harbor projects; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, institutional, religious and other buildings.

Week ended	Public Work	Private Work	Total U. S.
December 29, 1927.	$16,437,000	$64,165,000	$80,602,000
December 22, 1927.	23,599,000	41,777,000	65,376,000
December 30, 1926.	12,900,000	18,719,000	31,619,000
Total For Year			
1927	1,255,240,000	1,998,526,000	3,253,766,000
1926	1,089,155,000	1,764,692,000	2,853,847,000

E.N.-R. Index Numbers

On December 1, 1927

COST	VOLUME
203.90	272
Last Year 210.80	Last Year 211

The Index Numbers are published in detail and with charts in the first issue of each month. The Cost Index is given in full from 1903 through 1926, with a thorough explanation of its method of computation, and a graphic comparison with many other index numbers, in the 48-page pamphlet entitled Engineering News-Record Construction Costs.

Weekly Construction Market

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, per 100 lb.	$3.34	$3.75	$4.00	$3.10	$3.35	$3.95	$3.00	$3.00	$4.00
Structural rivets, per 100 lb.	5.00	4.00	4.75	3.60	3.85	4.64	5.75	5.25	5.50
Reinforcing bars, per 100 lb.	3.24	2.99	2.75	2.50	2.87½	3.87½	2.95	3.00	3.57
Steel pipe, black, 2½ to 6 in., lap weld, discount from list	48%	40%	54%	51%	48%	41%	42@53.8%	48%	.....
Cast-iron pipe, 6 in. and over, per net ton	38.60	36.50	52.00	34.60	40.00	52.00	48.50	53.00	48.00
Concreting Material									
Cement, without bags, per bbl.	2.25@2.35†	2.45	2.05	2.05	2.22	2.85	2.51	2.65	1.41
Gravel, ¾ in., per cu.yd.	1.75	.....	2.38	2.00	1.25*	1.90	1.80	1.00	1.50*
Sand, per cu.yd.	1.00	1.75	2.00	2.00	1.25†	1.00	1.40	1.00	1.25*
Crushed stone, ¾ in., per cu.yd.	1.85	.....	2.75	2.00	1.25*	2.50	1.70	1.90	2.00*†
Miscellaneous									
Fir, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.	.....	.....	.....	39.50(S&S)	36.75 @38.75	33.75	27.00	24.00	50@55
Pine, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.	60@62†	34.00	56.00†	.....	.....	.....	.....	.....	.....
Lime, finishing, hydrated, ton	22.50@24.50†	21.50	19.00	20.00†	25.50	24.00†‡	27.50	24.00	21.00
Lime, common, lump, per bbl.	3.25@3.50†‡	1.25	1.82	1.50†	1.70	2.70†‡	1.70	2.80‡	10.00*
Common brick, per M	16.00@17.00†	11.50	13.50	12.00†	13.75†	8@12	13.00	14.00	20.25
Hollow building tile, 4x12x12, per block	.....	.068	.094	.....	.072	.085	.....	.10	.10
Hollow partition tile, 4x12x12, per block	.0966	.068	.094	.076†	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	.79½	.81¾	.85	.76	.84	.85	84	.98	.90
Common Labor									
Common labor, union, per hour.	.90¾	.30	.....	.90	.....	.....	.50@.60	.70	.....
Common labor, non-union, hour.	.....	.25	.30@.50	.82½	.45@.60	.31¼@.50	....	.62½	.30@.35

*Ton. †Delivered to job. ‡280-lb. net. +Advance. —Decline.

DEMAND for heavy engineering construction in 1927 exceeded that of last year by at least 14 per cent, according to *Engineering News-Record* statistics, outlined in the table at the top of the page.

This year, as in 1926, public work constituted about 38 per cent of the total value of contracts let. The gain in privately owned projects was fully as heavy as that of public awards.

With wages of skilled building trades mechanics consistently above 1926 levels, materials prices have eased off sufficiently to give a general cost level that is approximately 1 per cent below the 1926 average. The *E. N.-R.* Construction Cost Index Number at the top of the page is based on 1913 as 100.

Contracts for public improvement cover water-works, sewers, bridges, streets, roads, and awards made by the Federal, state, county, or municipal authorities. Private projects consist mostly of industrial and commercial buildings, with a considerable number of hotels, apartments, educational, institutional, and religious structures. The minimum adopted in each class, as stated in the table, is necessary in order to exclude from the figures all jobs too small to be of interest to the engineer.

THIS limited price list is published weekly except in the first issue of each month and gives current prices on the principal construction materials in nine representative cities. Valuable suggestions on costs of work can be had by noting actual biddings as reported in the Construction News and Unit Prices sections following.

The first issue of each month carries complete quotations for all of the basic materials and for the rest of the important cities, also wage rates for the principal building trades and common labor. The last complete list will be found in the issue of Dec. 1, the next on Jan. 5. Explanation of prices contained in the table will appear from time to time in this section; last shown Dec. 22, 1927, p. 1026.

Price movements of the last week, sufficiently far reaching to have more than a local effect, were the increasingly upward tendencies shown by steel, other than sheets; the seasonal softening of portland cement quotations; and the slightly firmer postion of softwood lumber.

The brick price situation will improve, from the manufacturers standpoint, as seasonal curtailment in output reduces the present over-supply.

Weakness prevails in the pig iron market despite the increasing firmness of fabricated steel. Reinforcing bars, plates, and shapes hold firmly to the price of $1.80 per 100 lb., base, Pittsburgh, for carload lots or over.